MECHANICAL ENGINEERING

· APRIL 1950 ·

Description of an Automatic Data-Analyzing Machine . . . . . B. S. Benson 285

Using Special Machinery to Increase Production . . C. A. Nichols 289

Panels for Apparatus Used in Communications Equipment . . . . . A. S. Muessen 295

The Engineer as a Manager . . . . . J. M. Juran 300

Progress in Railway Mechanical Engineering, 1948-1949 . . 303

Heat-Exchange Equipment for a 5000-Kw Gas-Turbine Generator . . . . . G. R. Fusner 316

Departments

Briefing the Record, 321

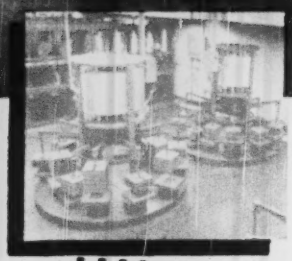
ASME Technical Digest, 335

The Engineering Profession—News and Notes, 351

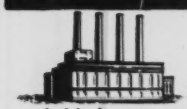
ASME News, 354

Buyer's Catalog Guide (*Advertisers*), 41

Keep Informed (*Advertisers*), 61



measuring steam-power progress in millionths of an inch



Indicative of the prodigious exploration and development work behind every technological advance in steam-electric generating practice are these scenes from B&W's new laboratory at Alliance, Ohio. Here, in one of the largest research laboratories of its kind, are conducted tests on the "creep" (plastic flow) and stress-rupture of metals. So precisely uniform are these testing units that temperatures are held to plus or minus one degree F at 1550 F; so accurate that specimen elongations are measured in millionths of an inch.

From such studies in steel come those savings in steam with which B&W Boilers and component equipment have been associated for more than 80 years. For these data on the behavior of metals under a wide variety of pressure-temperature conditions, along with investigations of fuel burning methods, heat recovery, and boiler design, are indispensable pre-requisites to the modern high-temperature, high-pressure boiler.

In the future, as in the past, B&W's great research organization will continue to contribute importantly to any project involving cheaper, more dependable power generation—will spend still more in helping you . . . and the power-consuming American public . . . to *save.*

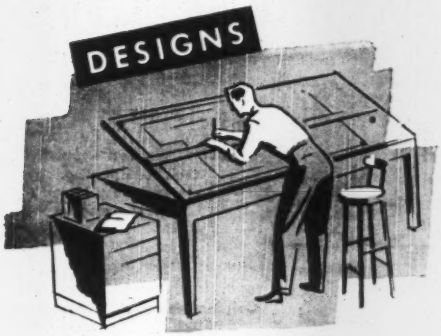
Helping Industry Cut Steam Costs Since 1867

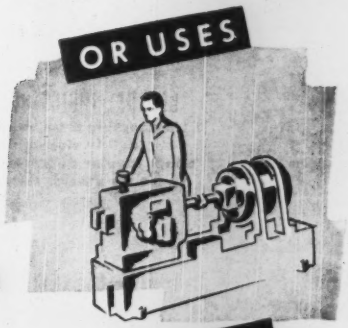
BABCOCK & WILCOX

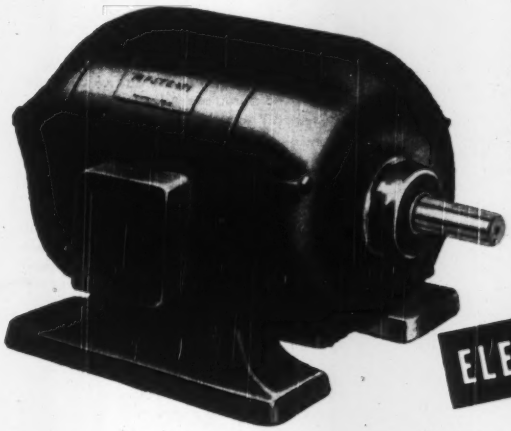
G-479

HOW TO SAVE MONEY

IF YOU ARE A MAN WHO...







ELECTRIC MOTORS

As almost everyone knows, many modern electric motors never need re-lubrication.

They run—an ever-increasing number of them—on New Departure self-enclosed ball bearings. For these are the bearings which (1) keep lubricant in, (2) keep dirt out, (3) reduce maintenance, and (4) simplify design.

These New Departure ball bearings save motor users money in several ways. They reduce lubrication costs to zero! They eliminate burnouts, costly repairs and lost time due to over or undergreasing. And they make motors last longer—as evidenced by numbers of installations that have been running for many years without attention.

Yes, you can save money by being certain the electric motors you design or manufacture or use are equipped with New Departure self-sealed ball bearings. Interesting booklet "Sealed" will be mailed on request.

Nothing Rolls Like a Ball . . .

NEW DEPARTURE
BALL BEARINGS

NEW DEPARTURE
DIVISION OF GENERAL MOTORS
BRISTOL, CONNECTICUT

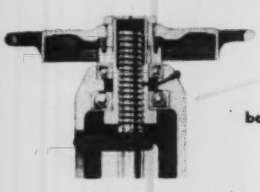
91

MECHANICAL ENGINEERING, April, 1950, Vol. 72, No. 4. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price 75¢ a copy, $7.00 a year; to members and affiliates, 50¢ a copy, $4.00 a year. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the act of March 3, 1879. Member of the Audit Bureau of Circulations.

You get all these features in

THESE WERE EDWARD FIRSTS!

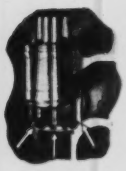
IMPACTOR* HANDWHEEL
Maximum closing torque in minimum space. An all time high in valve design.



EVALTHRUST* YOKE BUSHING
Patented ball bearing construction for easy valve operation.

CLOSURE INDICATORS
No guessing if valve is tightly closed for either regular operation or for special tests.

LOW PRESSURE-LOSS BODY CONTOURS
Both globe and angle bodies let maximum flow through. Pioneered by Edward. Copied but never bettered.



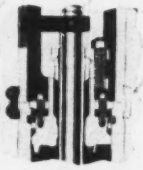
THREE-POINT GUIDING
Streamlined, cored out guide ribs, integral with body, keeps disk in alignment. Dangerous stem guiding eliminated.

SELF-CENTERING DISK THROTTLING LIP
Avoids jamming or cocking, assures tight seating, prevents wire-drawing.

*Registered trade names of Edward Valves, Inc.

FREE FLOATING TUBULAR DISK-PISTON
Quicker opening, surer closing, flow tested for less pressure loss.

EQUALIZER
Original design. Gives higher, surer piston lift, lowers pressure loss, eliminates wear-producing vibration.



EDWARD PRESSURE-SEAL DESIGN
First pressure-seal non-return valves were built by Edward. Pressure-sealing parts do not guide floating disk-piston, insuring a permanent seal.

INTEX* INTEGRAL SEATS
Hard facing applied directly to valve body completely eliminates possibility of leaks behind screwed or welded-in seat rings.

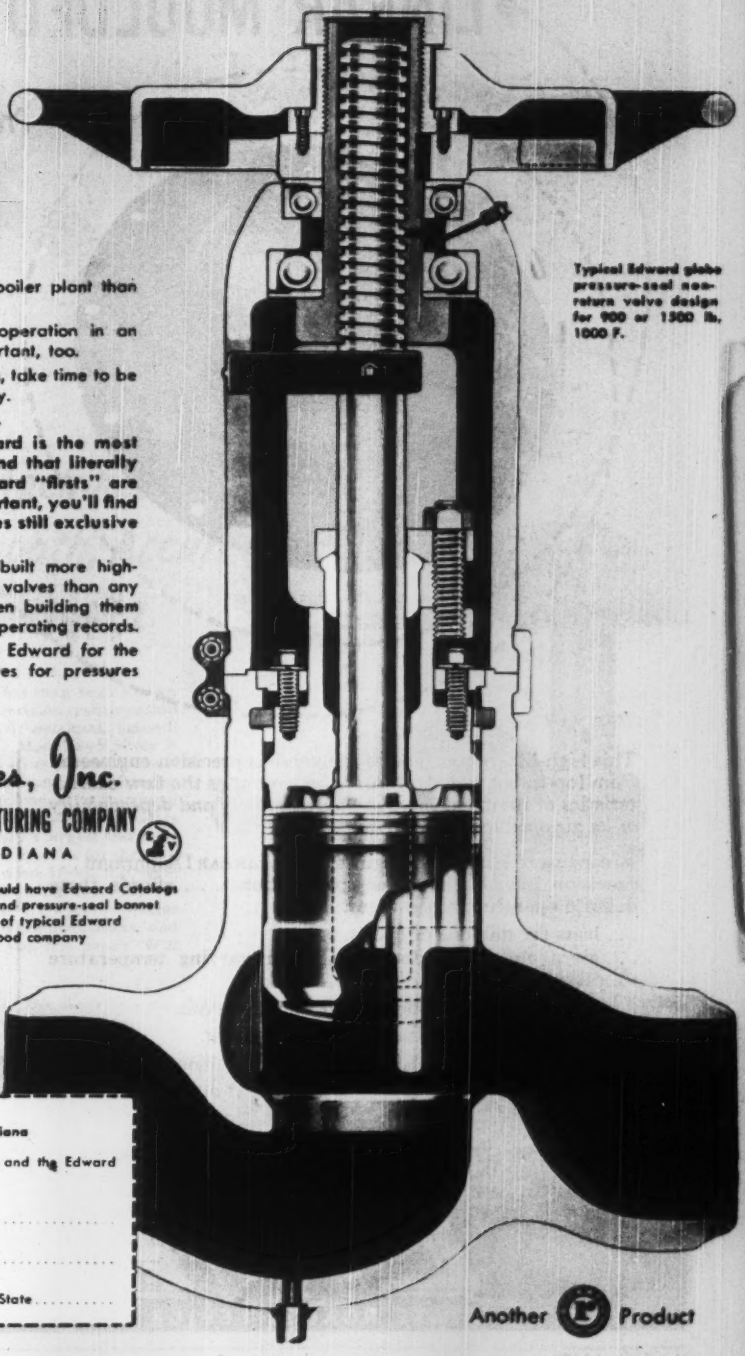
These are also Edward Firsts!

Evalized* plating of valve parts for wear and corrosion resistance . . . Patented welded-bonnet Univalves* . . . Impactor* handles for small valves . . . Seat located guide ribs in gate valves . . . No-bonnet instrument valve construction . . . Intex* Stellited welded-in seats . . . Hour-glass type disk-piston . . . EValpak* packing . . . Separated feedline stop-check valves . . . Screwed and welded flanges for forged steel valves . . . Swing bolt retaining washer construction, and

Patented Interchangeability of Stop, Check and Non-Return Valves . . . **Greatest possible valve flexibility for your plant!**

Edward Non-Return Valves

DON'T SETTLE FOR LESS!



Typical Edward globe pressure-seal non-return valve design for 900 or 1500 lb, 1000 F.

No valve is more important in your boiler plant than your non-return valve.

From it, you expect quick, sure operation in an emergency. Low pressure loss is important, too.

Next time you buy non-return valves, take time to be sure. Go into design features carefully.

Also, look at actual service records.

If you do, you'll find that Edward is the most copied valve in the field. You'll find that literally dozens of features that were Edward "firsts" are now industry standards. More important, you'll find there are still many patented features still exclusive with Edward.

You'll also find that Edward has built more high-pressure high-temperature non-return valves than any other manufacturer . . . and has been building them for more years, piling up unmatched operating records.

Don't discount experience. Look to Edward for the best and the first in non-return valves for pressures from 150 to 2500 lb sp.

Edward Valves, Inc.

Subsidiary of **ROCKWELL MANUFACTURING COMPANY**

EAST CHICAGO, INDIANA

ASK FOR THESE CATALOGS • You should have Edward Catalogs 12-B and 12-H, covering non-return valves and pressure-seal bonnet valves in your file. Also, we'll send you a list of typical Edward non-return valve installations to show what good company you'll be keeping if you specify Edward.

Edward Valves, Inc.
1350 West 145th Street, East Chicago, Indiana

Please send me Catalogs 12-B and 12-H and the Edward non-return valve installation list.

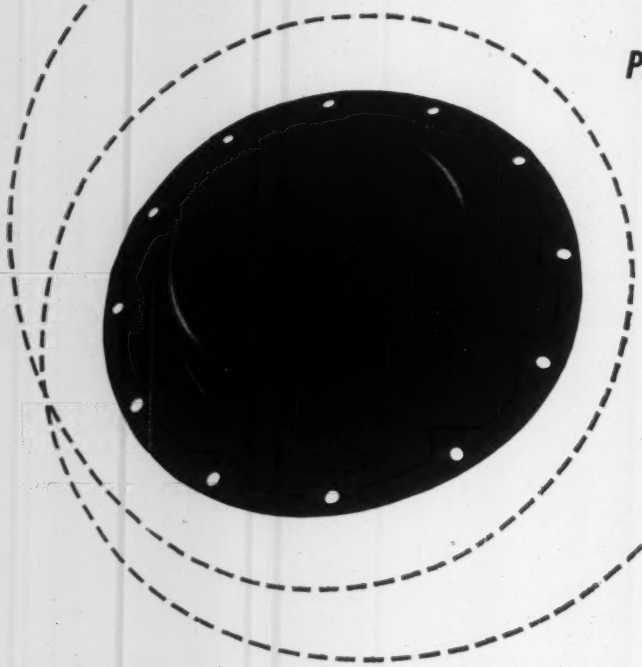
Name .....

Street .....

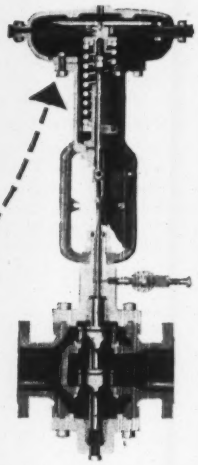
City ..... Zone ... State .....

Another Product

Keeping the Pulse of Automatic Control . . . with a LINEAR MOULDED DIAPHRAGM



A Special LINEAR Precision Moulded Diaphragm is the heart of this Honeywell Series 700 Control Valve



This high-lift, proportional type valve is precision-engineered from top to bottom. And *just as important* as the flow characteristics of its inner valve are *the sensitivity and dependability of its air-operated diaphragm*.

According to Honeywell engineers, this LINEAR Diaphragm . . . precision moulded to their specifications . . . affords these definite operating advantages:

. . . lasts for millions of cycles.

. . . gives uniform performance under varying temperature conditions.

. . . remains sensitive throughout its service life.

. . . withstands accidental overload pressures.

. . . permits smooth action for minute movements.

. . . provides a pressure-tight seal without strain on the cast flange.

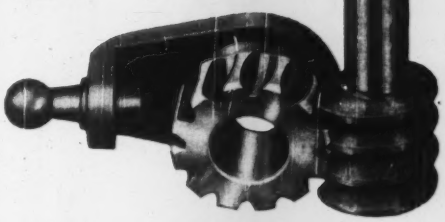
Your diaphragm problems can be solved, by LINEAR, with the same special engineering attention. Whether you need heavy-duty, fabric-reinforced diaphragms or the super-sensitive homogeneous type . . . Your individual specifications will be our guide. Write, wire or call LINEAR today!

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK STREET, PHILADELPHIA 35, PA.

U. S. Slicing Machine Company has long been known for the fine engineering and precision craftsmanship employed in the manufacture of their products. Smooth operation of the gauge plate in their Model 805 Slicer is assured by a G.S. worm and shaft as well as the worm wheel assembly pictured here. Isn't it significant that wherever *really fine precision* is an essential requirement in Fractional Horsepower Gearing, that's where you'll usually find Gears by G.S? More and more of our country's largest and most discriminating manufacturers depend upon us for the production runs of the Small Gears they need. If you, too, want *better,* more *uniform, longer-lived* Gearing correctly designed and cut to exacting specifications, put *your* problems up to our competent engineers. Suggestions, ideas, and moderate cost estimates won't cost you one penny! Will you write us today?



SEND FOR *free G. S. catalog-bulletin, describing many different types and applications of our Fractional Horsepower Gears.*

FRACTIONAL HORSEPOWER GEARS

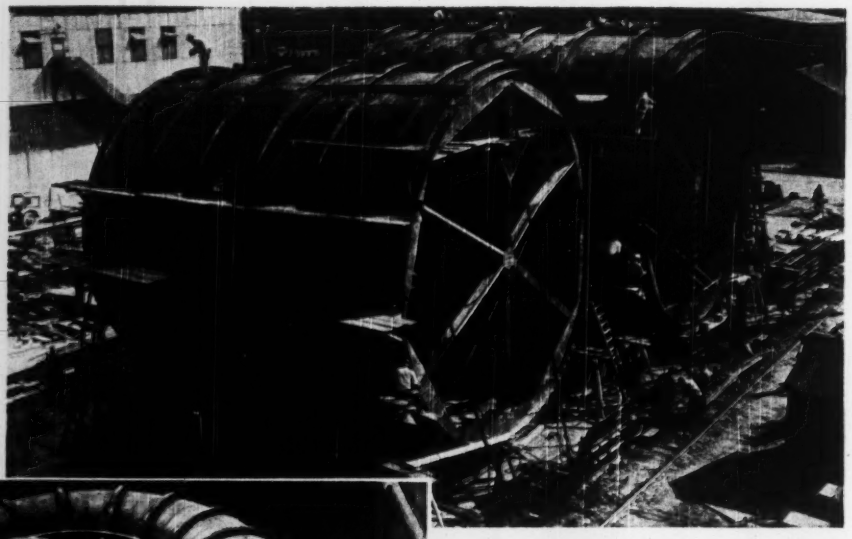
GEAR Specialties

Spurs • Spirals • Helicals • Bevels • Internals • Worm Gearing • Racks • Thread Grinding

2635 WEST MEDILL AVENUE · CHICAGO 47, ILLINOIS

MEMBER OF AGMA

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS



TO HARNESS THE ELEMENTS

Shown are shop erections of sections of a wind tunnel and a water turbine spiral casing at Newport News. One to be used in the development of America's planes of the future, the other to generate power in the world's largest hydro-electric development.

Tolerances required for the 34-foot diameter welded structure of the wind tunnel were: flushness or smoothness plus or minus 0.01″; fairness of structure 0.03″ and up to $^{1}/_{32}$″ in diameter.

Eighteen of the 165,000 horsepower turbines at Grand Coulee have been built by Newport News. Nine sections of the casings are cast steel and six are welded and cast. These turbine units are the most powerful ever built.

Refractory towers, pressure vessels, bridge cassions and other heavy equipment of special design are fabricated at Newport News. The plant, over a mile in length, includes welding and steel fabricating shops, machine shops, foundries and forge shop to provide the advantages of building the complete job.

"Facilities and Products" catalog will be sent if requested.

NEWPORT NEWS

SHIPBUILDING AND DRY DOCK CO.

NEWPORT NEWS, VIRGINIA

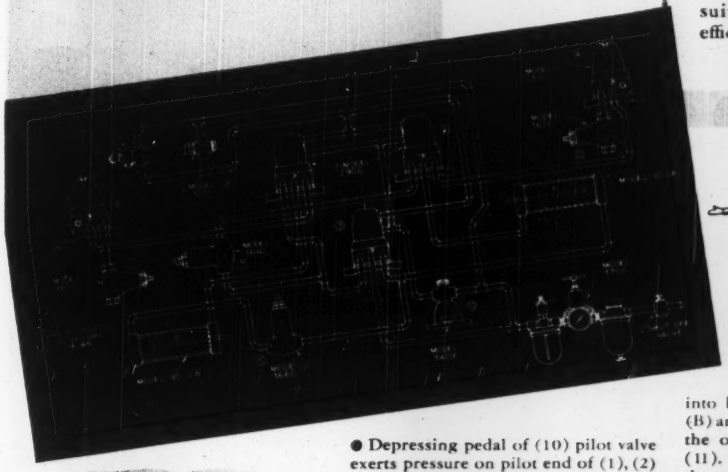
WHAT MAKES UP A *Good Air Circuit?*

1 **VALVES, CYLINDERS OF SUPERIOR DESIGN**

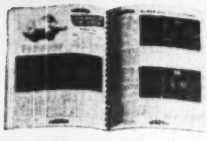
Gerotor meets this requirement with equipment designed by foremost engineers in the air field. Compactness of 4-way valves prevents fouling or leaking; large, convenient pipe connections allow unrestricted air flow. Cylinders, notable for absence of tie rods, have Keeper ring design, permitting compact installation.

2 **KNOWLEDGE OF APPLICATION**

Equally important is the know-how as demonstrated by Gerotor Factory and Distributor Representatives. These men possess the knowledge and experience to help you draw up the most suitable circuit to furnish efficient and lasting service.



AIR EQUIPMENT ON AN AUTOMATIC LATHE FOR CLAMP, TURNING AND CUT-OFF



Get Gerotor Catalog Sections No. 54 and No. 302 describing air valves and cylinders

Write to

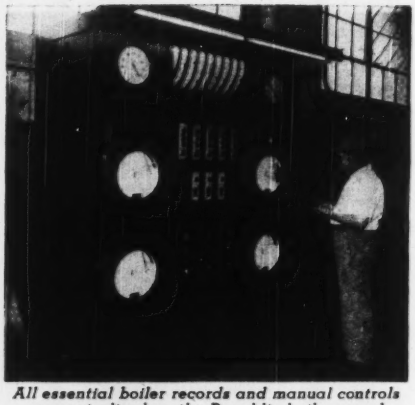
RIVETT LATHE & GRINDER Inc.
Dept. ME-4, Brighton 35, Boston, Mass.

● Depressing pedal of (10) pilot valve exerts pressure on pilot end of (1), (2) and (3) pilot operated 4-way valves. Air flows from valve (3) to blind end of clamp cylinder (A). Piston moves out rapidly, the air from rod end being exhausted thru (4) cam operated 4-way valve. When clamp cylinder rod (A) depresses cam of valve (4), exhaust air from cylinder is restricted (12), providing for a slow approach. When clamp cylinder engages work, pressure in supply line increases, causing sequence valve (5) to open. Air flows into blind end of cut-off tool cylinder (B) and a similar action takes place thru the out-stroke, by means of (9) and (11). After the cut-off, cylinder rod depresses cam of (6) pilot valve which, by pilot pressure, reverses valves (1), (2), and (3). Air line is then connected to the rod end of cylinder (B) and retracts cut-off tool. After cylinder completes return stroke, pressure builds up in supply line connected to sequence valve (7). Pressure opens valve (7) and allows air to rod end of clamp cylinder. After it retracts, cycle is completed. Pilot valve (8) permits interruption of cycle to retract cylinders.

WHEN YOU APPLY HYDRAULIC OR AIR POWER *Plan with* **GEROTOR**

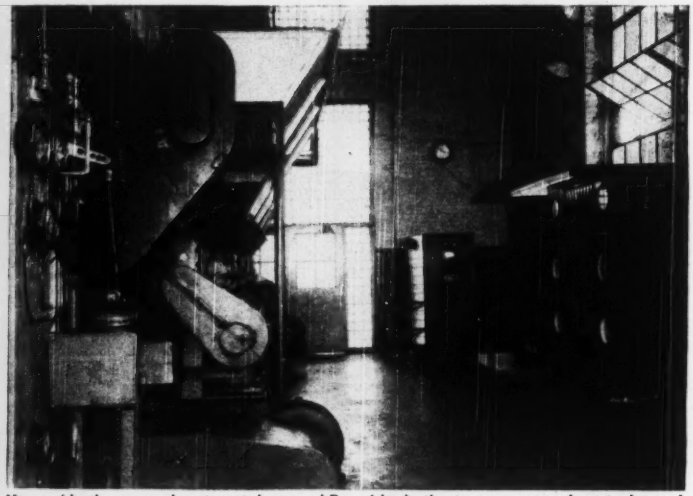
● the Municipal
Electric Light and Power
Plant of Hannibal, Missouri

[the home of Mark Twain and his famous characters, Tom Sawyer and Huckelberry Finn]



All essential boiler records and manual controls are centralized on the Republic boiler panel.

HAS THE ANSWER TO LOWER STEAM COSTS



View of boiler room showing stokers and Republic boiler instrument and control panel.

A REPUBLIC automatic combustion control system that operates their boiler at test standards, 24 hours a day, is the answer.

Installed at the Hannibal municipal plant is a modern three drum, 90,000 lb. per hour, 400 psi boiler with forced and induced draft fans and fired by a traveling grate spreader type stoker.

The REPUBLIC control system enables them to take full advantage of those economies which have been "built in" their boiler and its auxiliaries. It automatically increases and decreases simultaneously the fuel and air supply to the boiler in the correct amount to maintain constant steam pressure and in the correct ratio to maintain maximum combustion efficiency at all ratings.

The REPUBLIC combustion control system makes and co-ordinates these adjustments automatically, at the same time permits the operator to assume manual control from a centralized control point on the instrument panel whenever advisable.

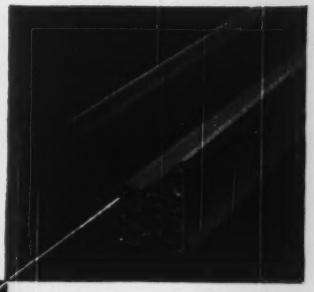
REPUBLIC combustion control systems are designed and built for all sizes of boilers—all types of fuel firing—all load conditions and any arrangement of draft equipment. We will be glad to supply full information on REPUBLIC Control Systems—just write for Data Book No. S-21.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

An imaginative automotive engineer used

Spongex® cellular rubber

to keep rattles and weather out for greater driving pleasure



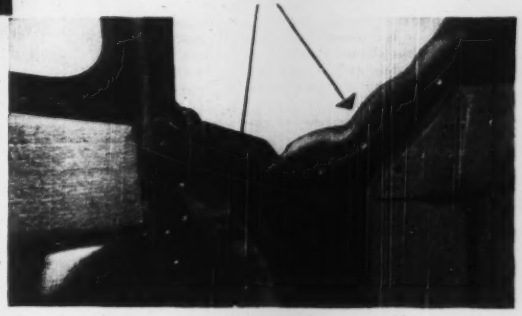
Suppose your car doors shut metal to metal! What a *crash* when you slammed them. What squeaks, rattles and groans as you drove along! And you'd get wet. You would freeze. It would *always* be drafty.

But a sponge rubber product seals out drafts, temperature and mojsture . . . cushions shock and vibration . . . absorbs noise. Doors shut snugly and quietly, slam after slam after slam.

If you have a vibration, insulation, cushioning, gasketing, sealing or sound damping problem, think about *Spongex*. Cellular rubber does not become a "product" until you make it one in *your* application. We welcome new problems.

Illustration below—The vertical cord is decorative and functional. This fabric covered Spongex cord seals out drafts.

On door and body are Spongex pieces molded around metal to afford reinforcement, rigidity and mechanical fastening.



Spongex forms shown are from molds designed by us and owned by our customers. As such they are not offered for sale. Similar products can be molded to your requirements in molds designed for you.

TECHNICAL BULLETIN ON SPONGE RUBBER AVAILABLE ON REQUEST

The World's Largest Specialists in Cellular Rubber

THE SPONGE RUBBER PRODUCTS COMPANY

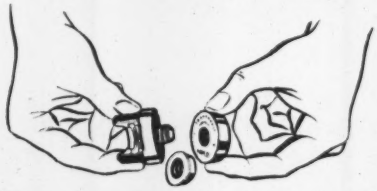
301 Derby Place, Shelton, Conn.

A versatile valve for general service . . .

LUNKENHEIMER Figure 123 N-M-D Non-Metallic Disc

150 lb. S.P.
300 lb.W.O.G.

The valve with the quick-change disc



STEAM • HOT WATER • COLD WATER
AIR AND GAS • GASOLINE • OIL • BUTANE • PROPANE

Ultra-modern Manufacturing Facilities

From raw material control to final testing, new machinery, methods and research improve the quality and speed the making of Lunkenheimer Valves. New production equipment, like the group of medium ram type turret lathes shown here, is but a small part of Lunkenheimer's extensive improvement program to provide users with the best possible valve service.

Fig. 123 is an exceptionally rugged valve . . . available with various types of discs especially compounded to give top results on the services for which they are recommended. Discs can be renewed or interchanged quick as a wink, insuring long-time satisfactory valve service with negligible maintenance expense. Disc holder is slip-on type, perfectly guided. Hexagon head gland is an aid to easy repacking. A further economy feature is the distinctive, long-wearing stem material developed by Lunkenheimer, eliminating stem-thread failure due to wear.

The "N-M-D" valve is also regularly available in angle, check and quick operating patterns. Circular No. 558, descriptive of the complete line, is yours for the asking.

N. M. D. and other Lunkenheimer Valves are available in all industrial centers. You can depend upon your Lunkenheimer Distributor for prompt service on your requirements.

ESTABLISHED 1862

THE LUNKENHEIMER CO.

"QUALITY"

CINCINNATI 14, OHIO, U.S.A.

NEW YORK 13 · CHICAGO 6 · BOSTON 10 · PHILADELPHIA 34

EXPORT DEPT. CINCINNATI 14, OHIO, U.S.A.

Paris gets 215,000 more kw's; KELLOGG provides all critical power piping!

ALONG with the need for rebuilding and expanding Europe's industrial capacity, there is a corollary need for more efficient power production, calling for higher operating temperatures and pressures. As these conditions approach and exceed 1,000 F. and 1,700 p.s.i., piping naturally becomes a major problem, demanding the most modern techniques for satisfactory solution.

For example, piping layouts for the two new 100,000 KW main turbines now installed at Gennevilliers Station were first checked on Kellogg's exclusive apparatus for determination of stresses under operating conditions.

But correct design is only one part of the problem resulting from the demand for higher efficiencies. These critical conditions call for special alloys, requiring expert fabrication and installation . . . they necessitate the creation of special devices, such as bi-metallic transition pieces that, to date, have been made only by Kellogg. And they make the quality of on-the-site stress relieving and non-destructive inspection of alloy welding a prime consideration.

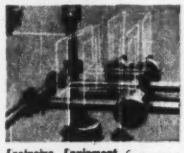
Kellogg has proven its power piping techniques in providing complete piping systems for high pressure and high temperature installations producing millions of kilowatts—of which more than 600,000 KW represents plants outside the United States. Currently, Kellogg is working on numerous power projects in Europe, South and Central America as well as in the U. S. Because of these widespread activities, Kellogg's experienced fabrication and installation crews are readily available to virtually any power producer throughout the world.

Special studies of unusual problems such as graphitization to assure long life and low maintenance.

Metallurgical research by recognized specialists who have made major contributions in this field.

KELLOGG

M. W. KELLOGG



Exclusive Equipment for accurately analyzing stresses in piping and providing unique data for critical installations.

Complete facilities for the fabrication of steel products from simple forgings to specially cast bi-metallic devices.

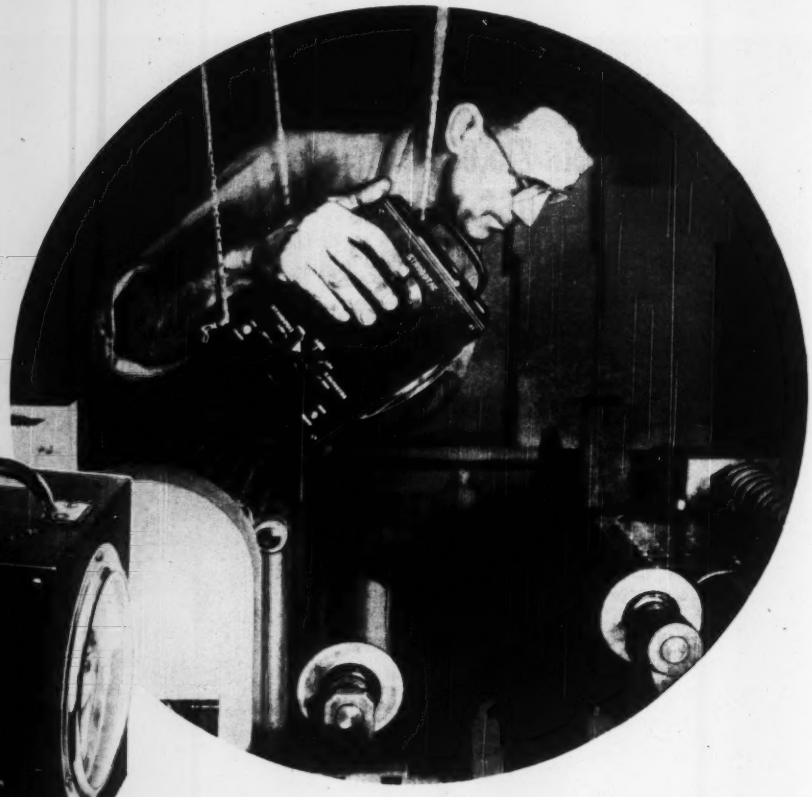
Top welding performance in shops and in the field by welders accustomed to working under X-Ray checks.

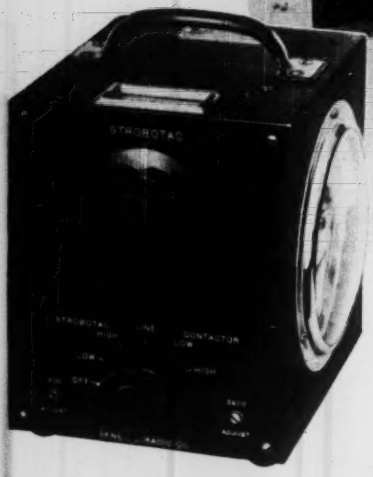
Quality control, devised by metallurgical experts, embracing forming, heat treating and non-destructive testing.

Vessels
Exchangers
Condensers
Process Piping
Forged and Welded Fittings
Radial Brick Chimneys

★

The M. W. Kellogg Company, Inc. (A Subsidiary of Pullman, Inc.) — Offices in New York, Jersey City, Buffalo, Los Angeles, Tulsa, Houston, Toronto, London and Paris





"Without these Strobotacs it would be difficult, if not impossible, to obtain the fine degree of accuracy necessary to our purposes"

STROBOTAC

Type 631-B

Flashing Speed Range: from 600 to 14,400 per minute, calibrated to read directly in rpm. Upper speed limit: 100,000 rpm.

Flash Durations: between 5 and 10 *millionths* of a second.

Power Supply: 115 volts, 60 cycles.

Power Input: 25 watts.

Dimensions: 7½ x 8¾ x 7⅞ inches.

Price: $125.00, ready to operate.

The American Thread Company of New York City also writes:

"We have two Strobotacs installed on our Champlain high speed rotogravure printing presses where they serve the important function of permitting the press operator to keep a continual watch on multi-color printing to insure accurate registration of the printed matter."

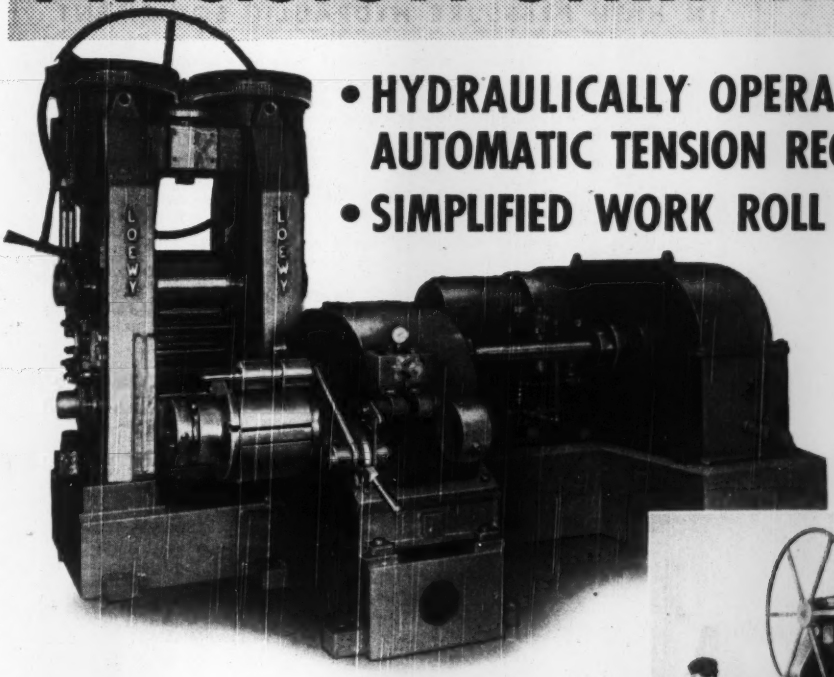
Here as in hundreds of instances, the Strobotac accurately measures the speed of moving parts inaccessible to other methods. By "stopping motion," the Strobotac flash (5 to 10 microseconds) reveals conditions and causes, effects and defects, previously hidden or obscured.

Write for your 24 page manual of stroboscopic techniques, "Eyes for Industry."

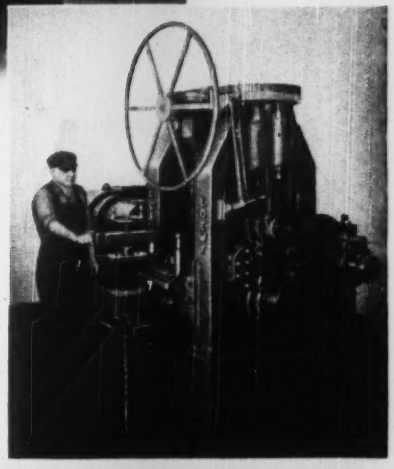
GENERAL RADIO COMPANY Cambridge 39, Massachusetts

90 West St., New York 6 920 S. Michigan Ave., Chicago 5 1000 N. Seward St., Los Angeles 38

MODERN 4-HIGH PRECISION STRIP MILLS



- HYDRAULICALLY OPERATED AUTOMATIC TENSION REGULATOR
- SIMPLIFIED WORK ROLL CHANGE



CUSTOM BUILT TO YOUR SPECIFIC REQUIREMENTS

WRITE FOR FULL INFORMATION

HYDROPRESS · INC ·

ENGINEERS *CONTRACTORS*

HYDRAULIC PRESSES · ACCUMULATORS · PUMPS

ROLLING MILLS

DIE CASTING MACHINES

572-574 *LEXINGTON AVENUE* AT 51ST STREET *NEW YORK 22 · N Y*

CHICAGO DETROIT SAN FRANCISCO SEATTLE WASHINGTON, D C

ROBERTSON

··A GREAT NAME··

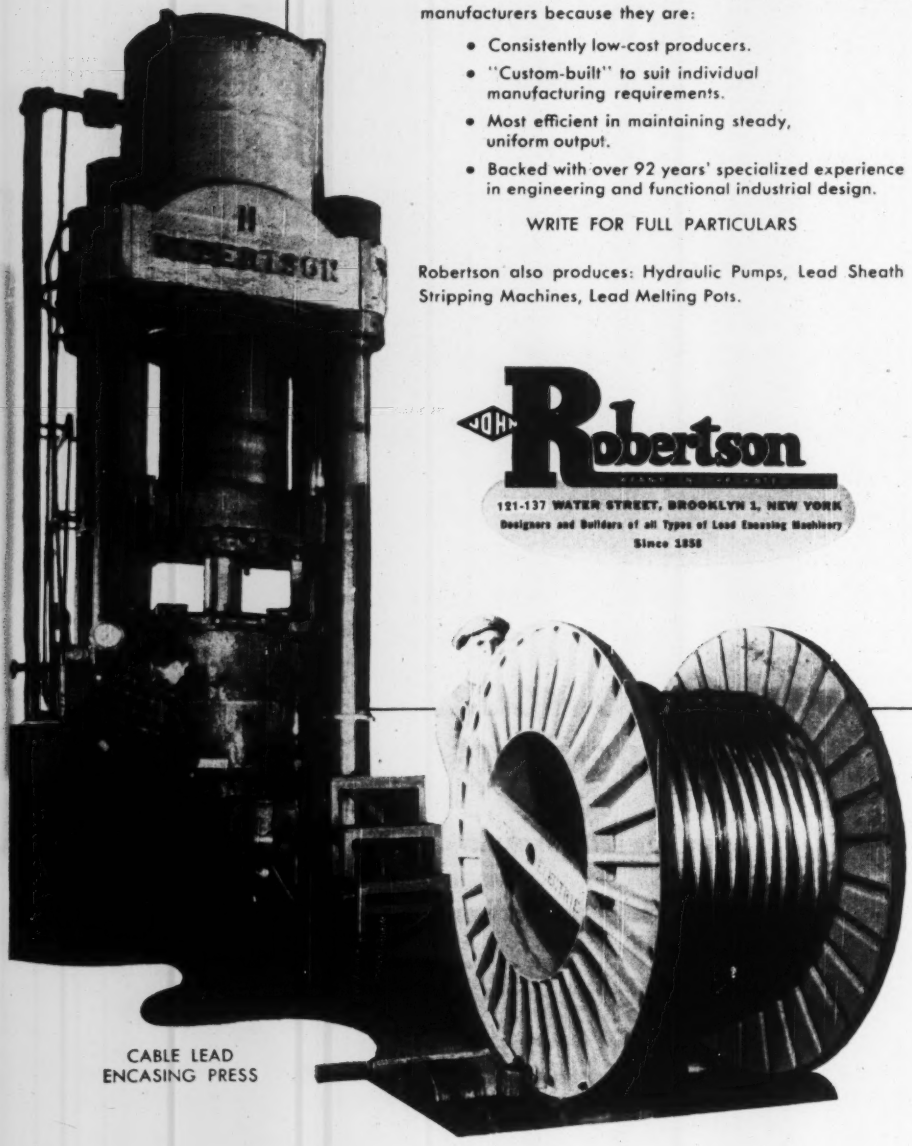
IN HIGH PRESSURE HYDRAULIC EQUIPMENT

Robertson Presses are first choice of many hose and cable manufacturers because they are:

- Consistently low-cost producers.
- "Custom-built" to suit individual manufacturing requirements.
- Most efficient in maintaining steady, uniform output.
- Backed with over 92 years' specialized experience in engineering and functional industrial design.

WRITE FOR FULL PARTICULARS

Robertson also produces: Hydraulic Pumps, Lead Sheath Stripping Machines, Lead Melting Pots.



CABLE LEAD ENCASING PRESS

JOH. Robertson

121-137 WATER STREET, BROOKLYN 1, NEW YORK

Designers and Builders of all Types of Lead Encasing Machinery

Since 1858

9 IMPORTANT ADVANTAGES IN FOOTE BROS. NEW HYGRADE DRIVES

1 STURDY CONSTRUCTION
Gearing, shafts, bearings designed for heavy duty applications. Rigid housings maintain accurate alignment.

2 HIGHEST QUALITY FOR LONG LIFE
All materials are of highest quality. Simple gear assemblies—small number of working parts—large antifriction bearings all contribute to long life.

3 COMPACT DESIGN
Advanced design assures compact space-saving units in keeping with ratio of reduction, mechanical and thermal capacities required.

4 BETTER GEARS
New developments in manufacturing result in precision generated worm gear teeth which assure higher efficiency and greater load-carrying capacity. Worms are integral with worm shafts. Helical gears and pinions are shaved for full tooth contact.

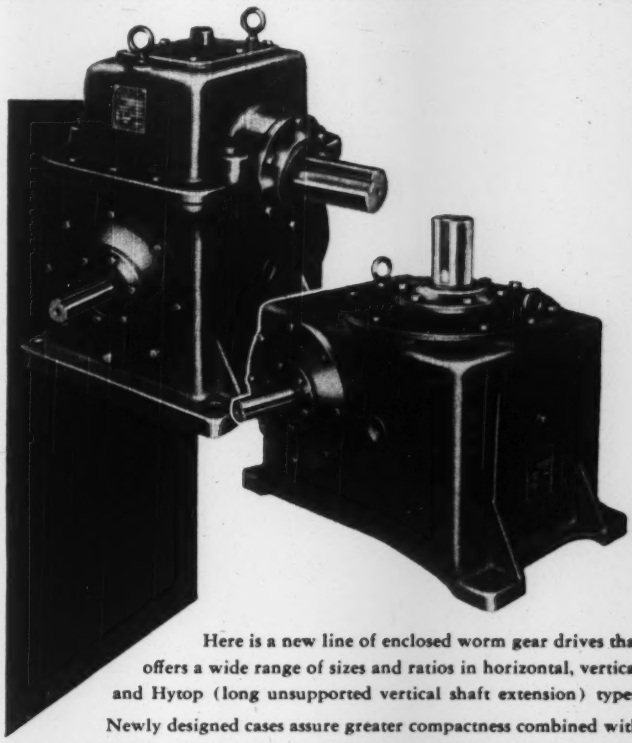
5 GREATER DEPENDABILITY
Advanced engineering, improved design, plus accurate control of finest materials, modern heat-treatment, and manufacture—all assure higher quality, greater dependability.

6 SMOOTH PERFORMANCE—QUIET OPERATION
Precision manufacture results in uniform tooth action giving smooth, quiet transfer of torque.

7 TROUBLE-FREE OPERATION
Totally enclosed oil-tight and dustproof housings—ample lubrication for all moving parts. Maintenance is held to a minimum.

8 WIDE RANGE OF TYPES—SIZES—RATIOS
Hygrade Reducers are available in horizontal, vertical and Hytop types. Hytop vertical design permits long, unsupported shaft extensions. Ratios 4⅛ : 1 up to 4108 : 1 (higher where required.)

9 STANDARD RATIOS—PROMPT DELIVERY
To assure prompt delivery, standard stock ratios have been developed. These are available on short notice.



Here is a new line of enclosed worm gear drives that offers a wide range of sizes and ratios in horizontal, vertical and Hytop (long unsupported vertical shaft extension) types.

Newly designed cases assure greater compactness combined with rigid construction. New manufacturing processes result in precision generated worm gears giving high efficiency and load carrying capacity.

An engineering manual, HGA, gives complete rating and dimension tables, engineering data, etc. Mail the coupon for your copy.

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOT BROS.—LOUIS ALLIS GEARMOTORS

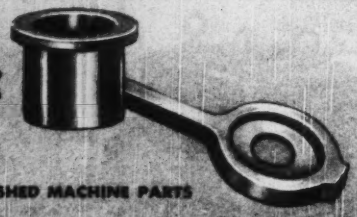
MAXI-POWER HELICAL GEAR DRIVES

HY-POWER WORM GEAR DRIVES

Foote Bros. Gear and Machine Corporation
Dept. Q, 4545 S. Western Blvd.
Chicago 9, Illinois
Please send me a copy of Engineering Manual HGA.

Name .....
Company .....
Position .....
Address .....
City ..... *State* .....

QUALITY



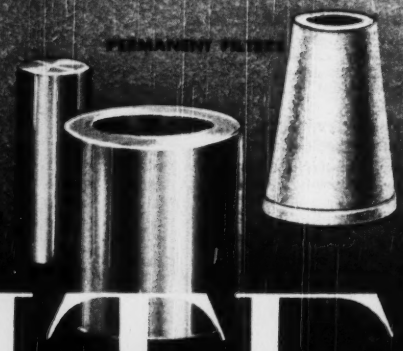
OIL-CUSHIONED BEARINGS

FINISHED MACHINE PARTS

★ 20 years of production experience.
★ New plant and equipment.
★ Virgin materials of highest purity.
★ Recognized management and technical personnel.
★ Electronic inspection devices and quality control.

SERVICE

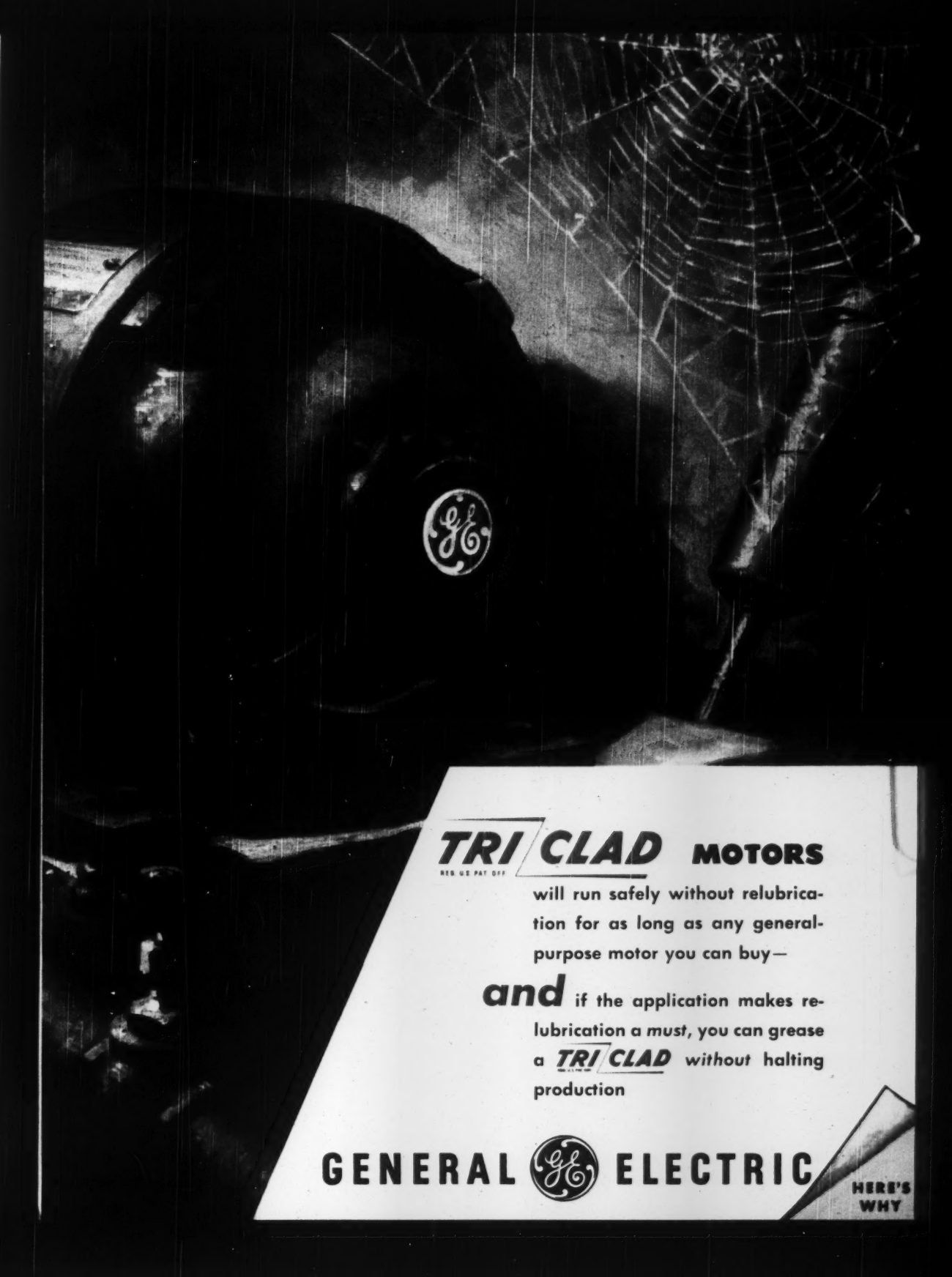
★ Extensive staff of home office and field engineers.
★ Batteries of presses and other equipment for quick service.
★ Production tools for more than 25,000 different finished products.
★ 3000 additional engineers for consultation on technical problems.
★ Depots in every state and throughout Canada for fast, easy service.



OILITE

AMPLEX MANUFACTURING COMPANY
SUBSIDIARY OF CHRYSLER CORPORATION
DETROIT 31, MICHIGAN

CONTACT OUR LOCAL FIELD ENGINEER OR HOME OFFICE


TRI CLAD MOTORS
REG. U.S. PAT. OFF.
will run safely without relubrication for as long as any general-purpose motor you can buy—
and if the application makes relubrication a must, you can grease a TRI CLAD without halting production
GENERAL ELECTRIC
HERE'S WHY

TRI CLAD MOTORS will run safely without relubrication for as long as any general-purpose motor you can buy—

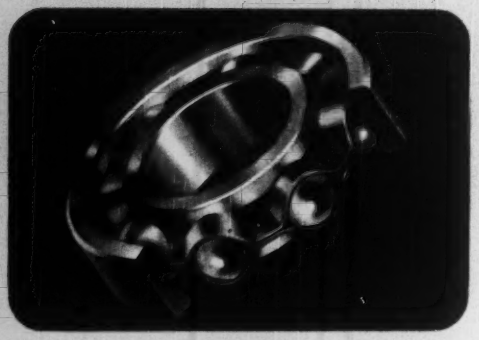
Tri-Clad extra lubrication "protection" can save you money because:

1. Tri-Clad's oversize grease reservoir and the heaviest standard-service bearings mean you do not have to bother with greasing between motor check-ups.

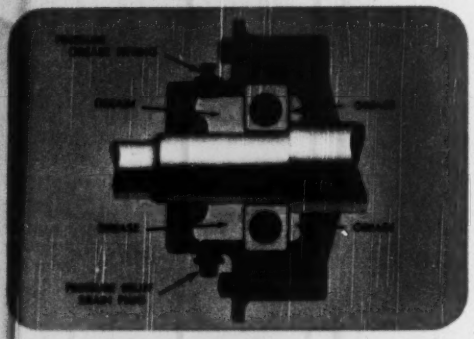
2. When relubrication is needed on those tough applications, you can grease a Tri-Clad without interrupting production-line operations.

Tri-Clads are grease-gun easy to lubricate *on the job*. Moreover, a Tri-Clad motor will run safely where an ordinary motor would fail. Chances are you'll be spared the cost of a "special" motor.

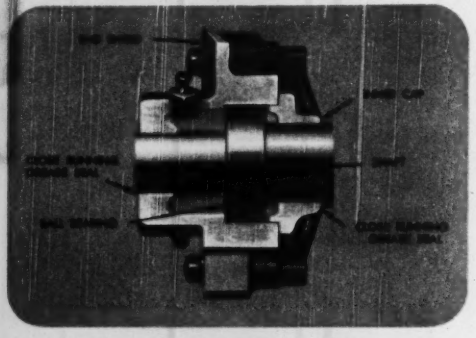
YOU BE THE JUDGE! The best way to prove to yourself that Tri-Clad gives you the most for your motor dollar is to contact your local G-E office. Tri-Clad stocks are complete. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*



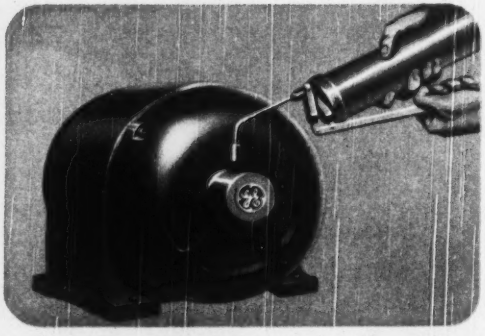
1 **EXTRA BEARING PROTECTION** — Tri-Clad gives you extra bearing protection because heaviest standard-service bearings are carefully selected to withstand severe loads for long periods.



2 **EXTRA GREASE** — Four times the ordinary amount of grease is packed into the large Tri-Clad grease reservoir. Since bearing life depends on grease, this means that Tri-Clad motors will run safely for years — for as long as any general-purpose motor you can buy.



3 **SEALED-IN BEARINGS** — Bearings and grease are completely sealed in a cast housing with long running seals for extra protection from dirt, dust, and lubricant leakage.



4 **PRESSURE-RELIEF GREASING** — An efficient system of pressure-relief lubrication (with standard fittings) enables a Tri-Clad motor to be quickly and easily greased on the job when and if it's needed.

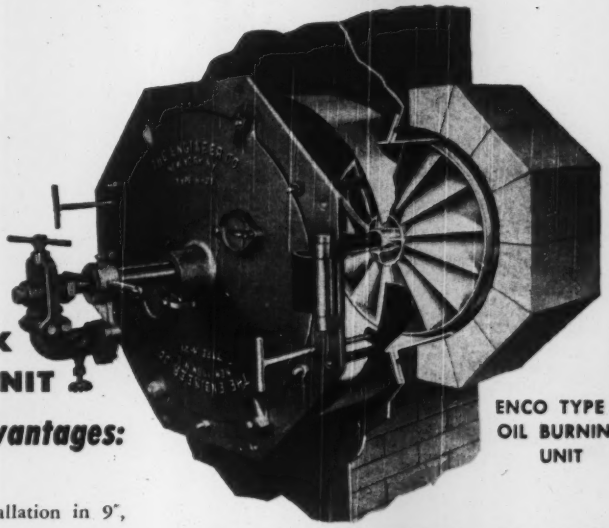
GENERAL ELECTRIC

NOW! uniform combustion efficiency from high peaks to low loads with the

ENCO TYPE K

OIL·GAS BURNER UNIT

HERE'S THE LATEST advance in burner units, designed to provide completely uniform combustion over the entire load range. The new ENCO Type K Oil-Gas Burner Unit is especially effective where steam demands swing sharply over short periods.

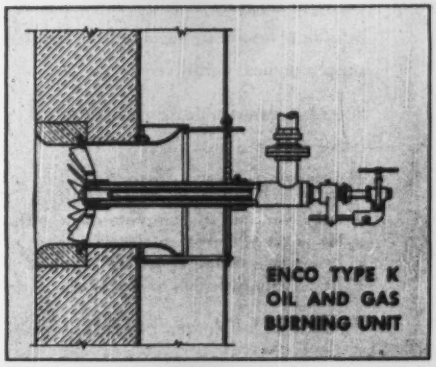


ENCO TYPE K OIL BURNING UNIT

THE ENCO TYPE K OIL·GAS BURNER UNIT *Offers These Additional Advantages:*

1 Natural or forced draft operation.
2 Register draft tube designed for installation in 9", 13½", 18" and 22½" furnace walls.
3 No movable blades.
4 Air vanes provide fixed turbulence over entire load range. Adjustable for long or short flame.
5 Air volume control damper.
6 Hinged door for easy access to internal parts for inspection or removal.
7 Suitable for either steam or mechanical atomizing type oil atomizers.
8 Gas burner gun can be added for combination of gas and/or oil.
9 Comes in a wide range of sizes and capacities.

This new Type K Unit is the result of pioneering research, aimed to help you achieve more efficient, more economical boiler operation. Write today for further information, or see your local Enco Representative.



ENCO TYPE K OIL AND GAS BURNING UNIT

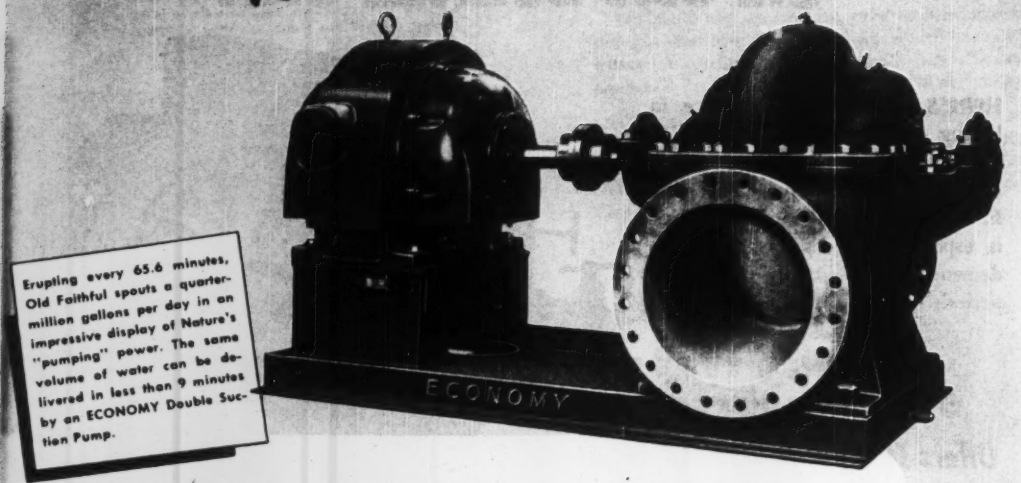
20-479

THE ENGINEER COMPANY

75 WEST STREET, NEW YORK 6, N. Y.

A DAY'S WORK FOR "OLD FAITHFUL"

...but just a 9 minute job for this ECONOMY PUMP



Erupting every 65.6 minutes, Old Faithful spouts a quarter-million gallons per day in an impressive display of Nature's "pumping" power. The same volume of water can be delivered in less than 9 minutes by an ECONOMY Double Suction Pump.

From 50 to 30,000 gallons per minute, there are more than 1500 models of this Economy Double Suction Pump . . . to meet your requirements for any capacity at heads to 300 feet. Designed for general purpose pumping of clear liquids at moderate heads, these single stage units are suited to general water supply or heavy mill service.

Sound hydraulic design give these Economy Pumps a broad, flat efficiency curve over a wide capacity range. Minimum maintenance is assured by sound engineering—based on such advantages as:

- **Easy removal of complete rotor without exposing bearings.**
- **No leakage between sleeve and shaft . . . shaft sleeves are sealed.**
- **Flanged wearing rings, "L" shaped, inward flow.**
- **Unusually effective water seals.** • **Large wells for lubrication.**

If you wish full details, our Dept. CM-4, will gladly send you Catalog A-1147.

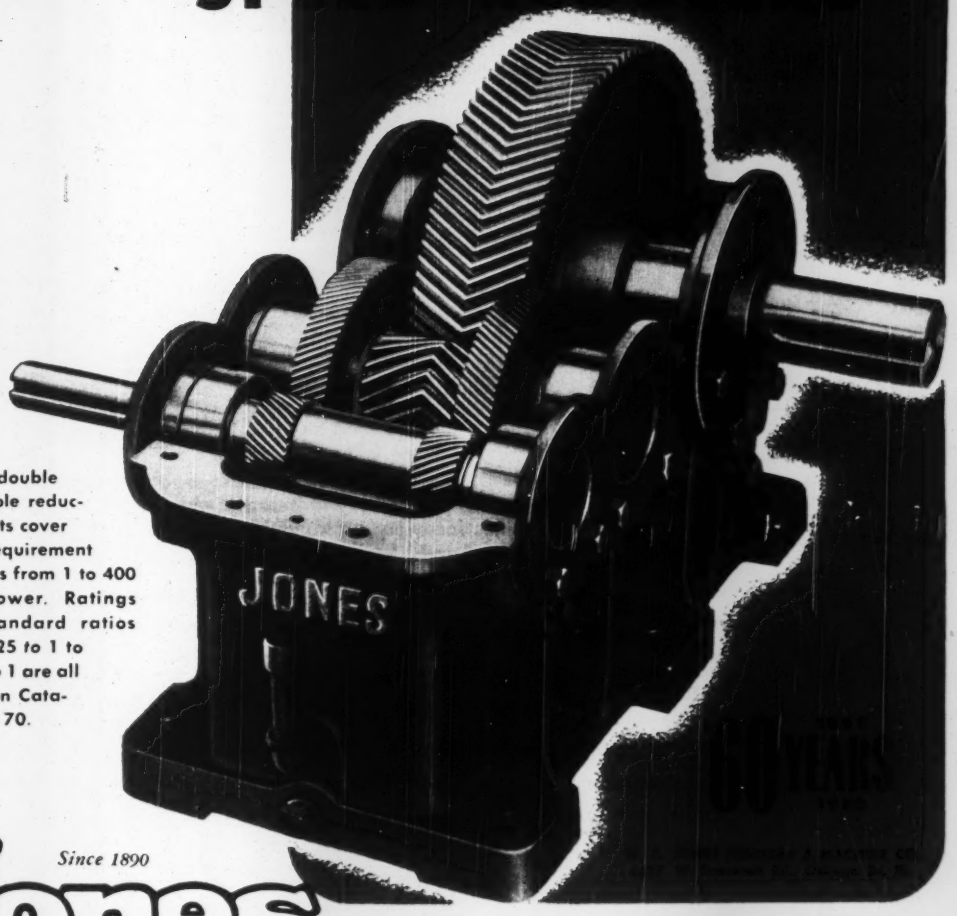
Economy Pumps Inc.

DIVISION OF HAMILTON-THOMAS CORP., HAMILTON, OHIO

Jones

Herring

SP



Single, double and triple reduction units cover every requirement in drives from 1 to 400 horsepower. Ratings and standard ratios from 1.25 to 1 to 355.8 to 1 are all shown in Catalog No. 70.

Since 1890

Jones

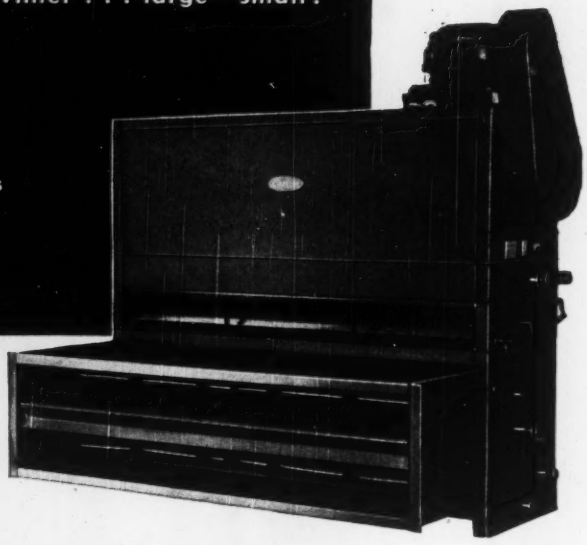
In The Service Of Industry

HERRINGBONE—WORM—SPUR—GEAR SPEED REDUCERS
PULLEYS • GEARS • V-BELT SHEAVES • ANTI-FRICTION
PILLOW BLOCKS • FRICTION CLUTCHES • FLEXIBLE COUPLINGS

call your cfm

There's a New Carrier Weathermaker
for every air conditioning job . . .
Summer—Winter . . . large—small!

1000 to
16,400 cfm
in single units



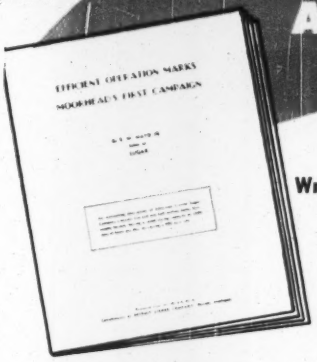
Wide range of capacities for every air conditioning load and function. Complete flexibility in arrangement of functional sections and components. New improved fan combines stable characteristic, efficiency, quietness. Roomy compactness with new fans and inclined coil saves space and weight. Designed for on-the-job accessibility, simplifying routine service and maintenance. Coil connections on either end simplify piping layouts. Rugged welded casing, proved sound over the years. Effective insulation prevents sweating, rubber paint retards rust. Built in the Carrier tradition of leadership for long life, dependable service. For information write Carrier Corporation, Syracuse 1, N. Y.

Carrier

AIR CONDITIONING • REFRIGERATION • INDUSTRIAL HEATING

AMERICAN CRYSTAL SUGAR COMPANY
Moorhead, Minnesota

ANOTHER FOOD PLANT MAKES SAVINGS WITH DETROIT STOKERS



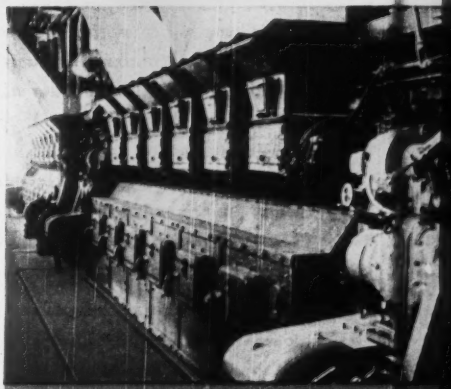
Write for this "Sugar" article

Heat is a major item in food processing. Fuel, therefore, is one of the main expenses. Coal, the "Basic Fuel," burned with Detroit Stokers is the Most Economical Method of Producing Heat. That's why leading Food Plants use them.

American Crystal Sugar Company uses ten Detroit Stokers in three Plants.

For their Moorhead, Minnesota Plant, they selected Detroit RotoGrates for two 110,000 pound steam generating units to process up to 3,000 tons of sugar beets a day.

An important factor in their decision was the necessity of being able to provide dependable steaming capacity with either 13,500 Btu Eastern Bituminous Coal or 6,800 Btu North Dakota Lignite, and to change readily from one fuel to the other if desired. The Lignite, burned has 29% moisture and 38% volatile.

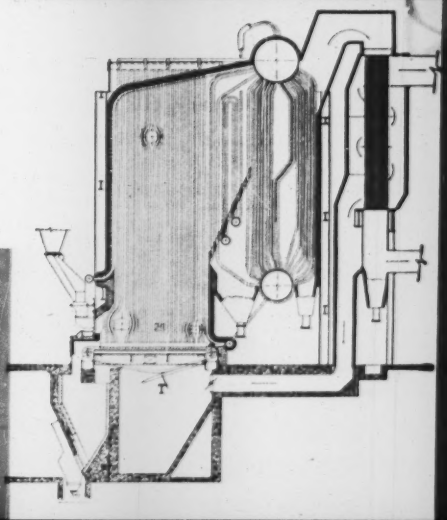


Detroit Stokers rated in 110,000 pound, two drum steam generators. Designed for 40 pounds up to 260° F.

Popular With Engineers

Cleanliness of Detroit RotoGrate firing combined with ability to handle fluctuating loads also appeals to Food Product Engineers.

You, too, can benefit by these operating advantages. Investigate now—no obligation.



WRITE FOR CATALOG TODAY

DETROIT STOKER COMPANY

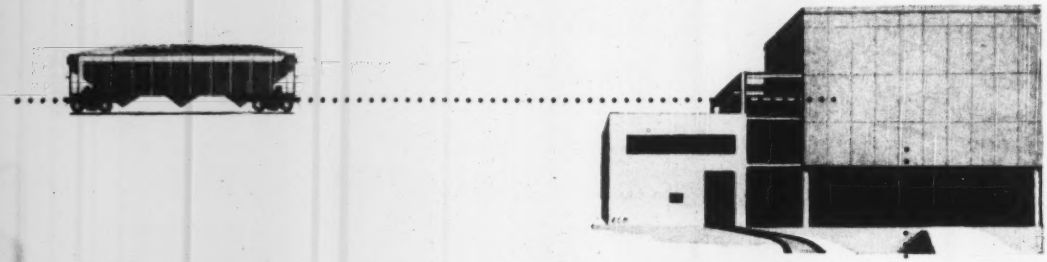
GENERAL MOTORS BUILDING, DETROIT 2, MICHIGAN
Works at Monroe, Michigan · Sales Offices in Principal Cities

OTHER TYPES AND SIZES OF DETROIT STOKERS FOR EVERY INDUSTRIAL OR POWER NEED

ONE OF A SERIES DEMONSTRATING APPLIED LUKENOMICS

HOW TO REGULATE A "RAT-HOLE"

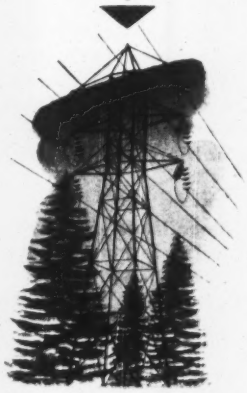
...and insure smoother, safer, gravity flow of materials from bunkers or hoppers



In designing equipment for the Gilbert Station of New Jersey Power and Light Company, provision was made to eliminate "arching" or "rat-holing" in coal bunkers to guarantee smooth flow to the direct-firing pulverizers. A 1400-ton bunker was constructed, the bottom five feet and four noses of which were built of monel-clad steel. The monel surface minimizes abrasion intensified by chemical corrosion, eliminating the packing of moist fines which leads to "arching" or "rat-holing". Steady feed is maintained without use of vibrators or a stand-by man. Both costs and danger of expensive firebox explosions caused by spotty stoking have been sharply reduced.

Strides in structural designs in the last two decades have resulted in increased efficiency . . . lower first costs and operating costs . . . improved performance. Many of the improvements have been the result of the cooperation between designer, engineer, fabricator and materials supplier. We call this Lukenomics. Such an approach is at your disposal to help solve your cost and amortization problems along with other vital considerations.

To obtain the advantages of equipment built by fabricators applying the Lukenomics principle, write our Manager of Marketing Service, Lukens Steel Company, 402 Lukens Building, Coatesville, Pennsylvania.

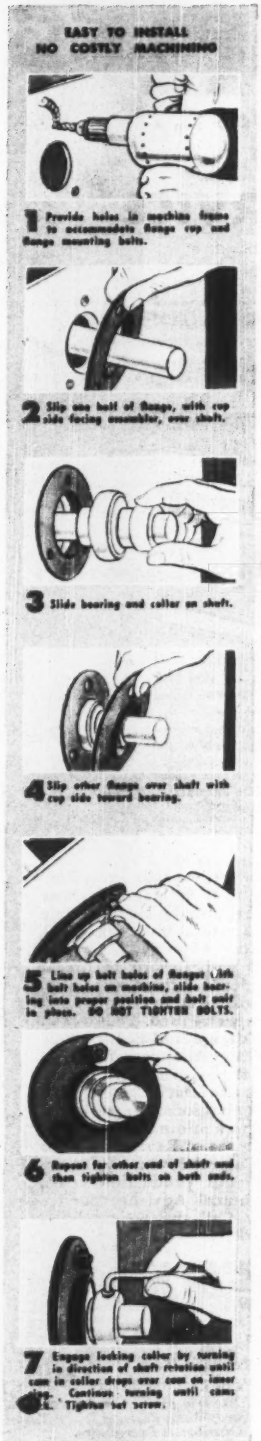


This new twist in hopper or bunker construction is a cooperative development of the New Jersey Power and Light Company, Gilbert Associates, Belmont Iron Works, and Lukens Steel Company. It was made practical because the differential in cost between Lukens Monel-Clad Steel and carbon steel could be counterbalanced within weeks from operating savings.

LUKENS

LUKENS STEEL COMPANY

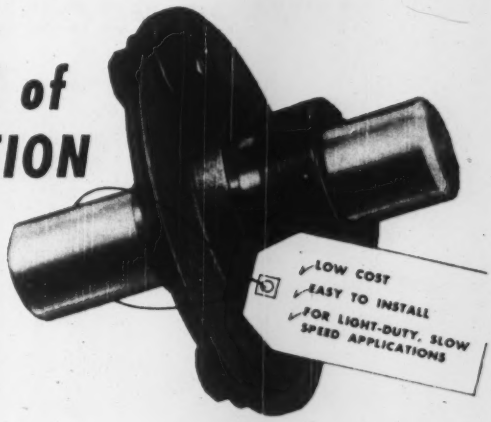
BETTER PRODUCTS FOR BETTER EQUIPMENT


EASY TO INSTALL
NO COSTLY MACHINING
1 Provide holes in machine frame to accommodate flange cup and flange mounting bolts.
2 Slip one half of flange, with cup side facing assembler, over shaft.
3 Slide bearing and collar on shaft.
4 Slip other flange over shaft with cup side toward bearing.
5 Line up bolt holes of flanges with bolt holes on machine, slide bearing into proper position and bolt units in place. DO NOT TIGHTEN BOLTS.
6 Repeat for other end of shaft and then tighten bolts on both ends.
7 Engage locking collar by turning in direction of shaft rotation until cam in collar drops over cam on inner race. Continue turning until cams lock. Tighten set screw.

Now you can equip your machines with ball bearings at *NEW LOW COST*

. . . with

NEW EASE of INSTALLATION



The Fafnir Flangette

incorporating the famous Fafnir Wide Inner Ring Ball Bearing with Self-Locking Collar

Now you can add ball bearing performance, power economy and longer bearing life to your equipment within your cost limits. A brand new, simple, low cost housing idea eliminates costly machining, makes maintenance easier. A pair of pressed steel flanges which can be bolted anywhere on your machine, provides a lightweight, compact, sturdy housing for a standard Fafnir Wide Inner Ring Ball Bearing. Curved contour of inside surface of flanges matches curving contour of bearing outer ring to provide full self-alignment when installing the unit. A twist of the collar locks bearing to shaft. Sealed both sides with Fafnir Mechani-Seals . . . a labyrinth design of interlocking steel plates. Write today for illustrated folder. The Fafnir Bearing Company, New Britain, Conn.

FAFNIR

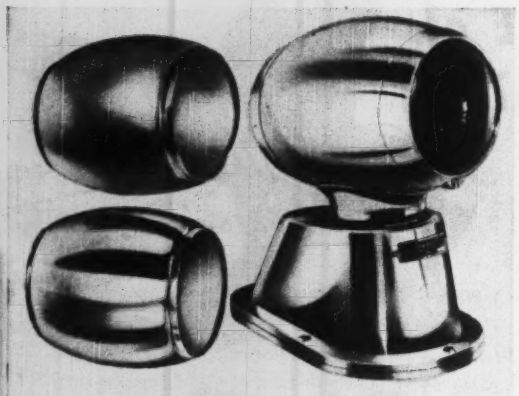
BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

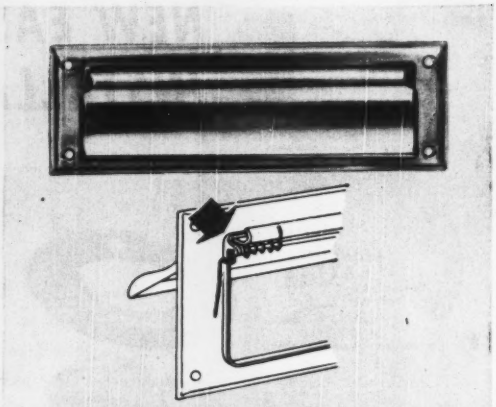
2 MORE EXAMPLES

how manufacturers improved their products . . .
cut production costs with the aid of

REVERE PRODUCTS and SERVICE



UPPER LEFT shows brass shell of the Rev-O-Lite as it comes from the bulging die. Without any extra finishing, which would have been necessary had shell been made of strip and brazed, shell is chrome plated as shown at lower left. At right is the completed assembly of the Rev-O-Lite ready for action on the roofs of all kinds of emergency vehicles such as police patrol cars, ambulances, fire trucks, etc. Chrome finish base is of cast zinc alloy.



THE LETTER BOX PLATE that is not only one of the first to be made from wrought brass but, the Ives Company tells us, has been generally accepted by the trade as the equal of similar items in cast brass. Another example of what can be accomplished when manufacturer and supplier work together.

Line drawing directly above shows detail of construction with Ives exclusive, Weather-Tite interlocking feature.

1. In the development of their Rev-O-Lite, a revolving warning light for emergency vehicles, the Balford Corporation, Jacksonville, Florida, found themselves faced with a production problem regarding the cylindrical shell which contains the lights. The question was; what would be the most efficient and economical way to produce this shell that measures 6″ in length and is 4½″ in diameter at the ends? Should it be formed from a metal strip and brazed? Could tube be used and bulged in a die? Or, should some other method be employed.

Revere, working with the design engineers of the Balford Corporation, exchanged ideas, weighed the pros and cons of various methods; experimented. They found that by using 70 30 Revere Brass Tube in a light anneal temper, it would take the bulging in the die satisfactorily and at the same time show up well as far as grain size control was concerned. By this method, complicated and costly forming operations and brazing could be eliminated; production speeded and the shell formed without any unsightly seam. Also, no extra hand finishing would be necessary before plating.

2. How can you make a letter box plate out of wrought brass and at the same time have it look like cast brass? This problem of the H. B. Ives Company, New Haven, Conn., came up while the Ives engineers were designing a new type plate employing a new method of interlocking the flap and the frame of the box to insure its being weather-tight.

Casting was ruled out as too costly and impractical to construct. If brass strip was used it had to be heavy enough to simulate cast hardware, yet sufficiently flexible to complete a U bend on a 7″ length without fracture or distortion. Also, because the finished plate would in most cases call for a natural brass finish, the stock had to be the right color.

After several consultations with Revere Technical Advisory Service and experiments in their own shop, it was suggested that Revere sheet brass of .062″ thickness and of a certain temper be used. That was it! The combination of proper design and heavy gauge metal resulted in a neat but rugged appearance. The wrought construction made it possible to produce a Weather-Tite plate with exclusive interlocking feature without costly machining operations. In addition, finishing costs were reduced to a minimum.

Perhaps one of the many types of Revere Brass or one of the other Revere Metals or Alloys can help you improve *your* product—cut your production costs. Why not tell Revere's Technical Advisory Service about *your* metal problems? Call the Revere Sales Office nearest you today.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801
230 Park Avenue, New York 17, New York
Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.
Sales Offices in Principal Cities, Distributors Everywhere.

BARRIER to SOUND and HEAT } "K" FELT

American Felt Company's "K" Felt is made to Army-Navy Specifications for applications where either sound absorption or thermal insulation, or both, are required. It is in wide use in airplanes, auditoriums, radio studios, and special automobile applications. Suitable for use at temperatures from below zero to 250° F. Made in rolls approximately 24 yards long and 72 inches wide, in thicknesses from ⅛ to ½ inch. Thicknesses over ½ inch are easily produced in your plant by layering. The engineering authority on the use of felt for sound and thermal insulation is American Felt Data Sheet No. 3, "K" Felt. Write for it today.

American Felt Company

TRADE MARK

GENERAL OFFICES: 50 Glenville Rd., Glenville, Conn. ENGINEERING AND RESEARCH LABORATORIES: GLENVILLE, CONN. — PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal.

PROPERTY	CHARACTERISTIC
K-Factor	0.21
Noise Reduction Coefficient, 1 in.	0.70
Flow Resistance, gm./sq. cm./sec., 1 in., Spec. AN-S-32	330
$\sqrt{RT}/S$, Spec. AN-S-32	50
Surface Density, lb./sq. yd./in.	3.24
Tensile Strength, lb./sq. in.	12
Compressive Stress, lb./sq. in. at 50% Deflection	3
Compression Set, 24 hr. loading at 50% Deflection	8%
Temperature Effect, −65° to 250° F.	None
Vibration Disintegration, Weight loss in 12 hrs. at 2000 c.p.m.	0.2%
Physical Stability in Handling or Flexing	Complete
Collapse When Wet	None
Shrinkage-Swell, A.S.T.M., D461	3%
pH Control	6.8-7.2
Corrosive Action, Aluminum, Magnesium and Alloys	None
Chemical Stability	Complete
Moisture Absorption, 24 hr. test at 125° F. and 96% R.H.	28%
Moisture Content, A.S.T.M., D461 Standard Condition, 65% R.H. at 70° F.	16%
Flame Resistance	
Propagation	None
Surface Flash	None
Afterglow, max.	30 sec.
Bacterial, Fungi and Vermin Resistance	Excellent

THICKNESS[1] Inches	SURFACE DENSITY		FREQUENCY Cycles per Second						NOISE REDUCTION COEFFICIENT[2]	CONDUCTANCE C BTU/Hr./Sq. Ft./°F.	RESISTANCE 1/C
	Lb./Sq. Ft.	Lb./Sq. Yd.	128	256	512	1024	2048	4096			
⅛	0.05	0.41	.02	.04	.06	.12	.28	.44	.10	0.85	1.17
¼	0.09	0.81	.03	.04	.11	.29	.56	.68	.25	0.68	1.47
½	0.18	1.62	.05	.07	.29	.63	.83	.87	.45	0.41	2.44
¾	0.27	2.43	.04	.17	.62	.82	.86	.83	.60	0.28	3.57
1	0.36	3.24	.06	.31	.80	.88	.87	.87	.70	0.21	4.76
										K-Factor	Resistivity
1½	0.54	4.86								0.14	7.15
2	0.72	6.48								0.13	7.69
2½	0.90	8.10								0.11	9.09

BASIC FORMULA FOR DESIGN ENGINEERS..... M=PT...

ENGINEERS in every field can benefit by following the formula M = PT (Morse means Power Transmission) when faced with complex or new design and application requirements.

Morse Power Transmission Products are important to engineers because they are ideally adaptable design-wise . . . and are available in a wide range of sizes, ratings and capacities.

NEW DRIVE SHAFT APPLICATION— A PROVEN SUCCESS STORY

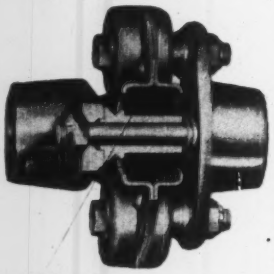
Self-propelled equipment engineers discover that Morflex Drive Shafts solve tough service and design problems encountered with engine front-end power take-offs

Equipment Builders using industrial engines and hydraulic units know that the best source of power for hydraulic pumps is the engine front end. To solve the problem of front-end torsionals, isolating vibration and shaft misalignment, engineers are now using Morse Morflex Drive Shafts.

Morflex Couplings are torsionally flexible, absorb shock, compensate for misalignment, reduce bearing wear and possible leakage from hydraulic pump seals.

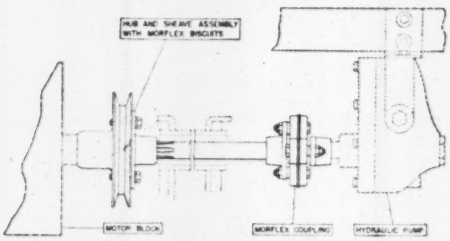
Morflex Drive Shafts with Morflex Couplings are readily adaptable to your front-end power take-off applications, too. Mail coupon below for Morse Morflex catalog which gives complete data on special and standard design adaptations.

Morflex Couplings which are used on Morflex Drive Shafts have no moving parts to wear, require no lubrication or maintenance—are not affected by water, dirt, oil or weather extremes.

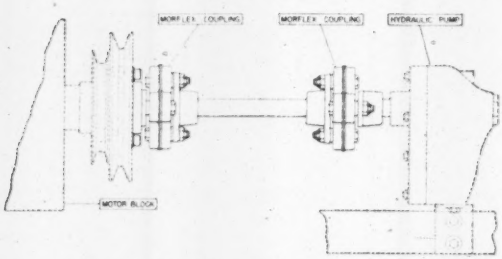


Neoprene biscuits

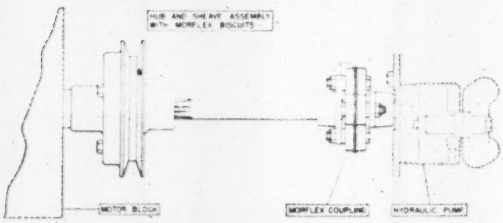
Actual front-end power take-off designs incorporating Morse Morflex Drive Shafts as applied to self-propelled equipment by leading manufacturers.



Tractor with front-end loader, using Morflex Drive Shaft.



Road equipment: front-end power take-off shaft connecting engine and hydraulic pump.



Industrial hydraulic lift truck: drive-shaft application.

CLIP COUPON . . . PASTE ON POST CARD . . . MAIL TO MORSE!

Morse Chain Company
7601 Central Ave., Dept. 511
Detroit 8, Mich.

Please send me 24-page Morflex Catalog C41-48.

Name _____

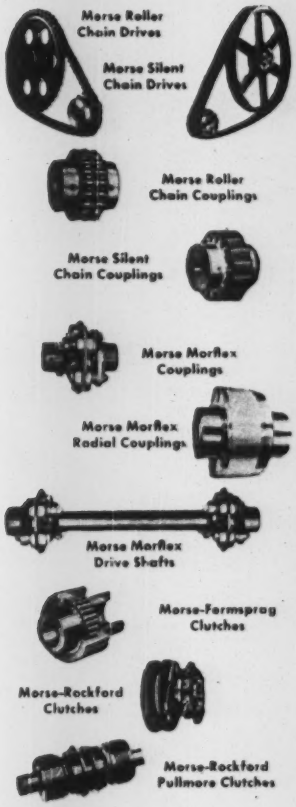
Title _____

Company _____

Address _____

City _____ Zone _____ State _____

. . . . . Morse *means* Power Transmission



Ask the Morse Man for power transmission information!

100 Morse Branch Offices and Distributors to supply your power transmission demands.

From coast to coast there are more than 100 offices, representatives and distributors of Morse Power Transmission products to give you quick information and service when you want it—where you want it. *Ask the Morse Man first in any case!* Check your classified phone directory under **"Power Transmission"** or **"Chains"** for the nearest Morse Man.

MORSE
MECHANICAL
POWER TRANSMISSION
PRODUCTS

PRODUCTS OF BW BORG-WARNER

ALL-ELECTRIC NORDSTROM-EQUIPPED MANIFOLD CONTROL

All-electric Nordstrom valve manifold controlling lines from fields to tank at Baton Rouge, Louisiana plant of Plantation Pipeline Company. Photo by Corsini, by courtesy of Standard Oil Company of N. J.

More and more the trend is toward power-operated valves. Lubricated plug valves are best suited for motor control. Minimum time is required to open or close a Nordstrom with its quarter-turn plug. There's no chance for a Nordstrom to be "not quite" closed. Positive rotary action of the plug insures full closure and a sealed circuit of lubricant hydraulically pressurized around each port. Our engineering staff will work closely with yours in developing the precise specifications to meet your needs.

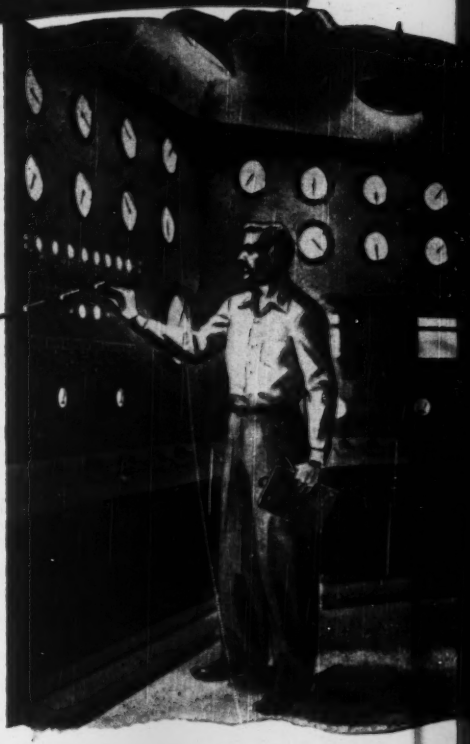
REMOTE VALVE CONTROL - most modern

Instant, centralized control of lines

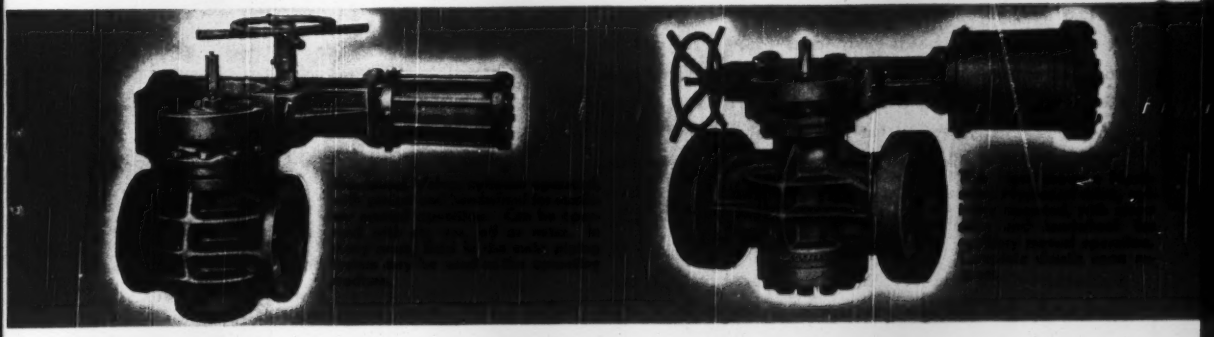
any distance ★

any pressure ★

any capacity ★



With Nordstrom electric motor or cylinder operated valves you can arrange control of your manifolds, pipelines and other remotely located operations independent of manual control. Standard cylinders are available for installations in which this type of control is preferable. For operating pressure ranges from 50 to 200 lb. gauge pressure, complete with cylinder mounting bracket and all operative parts assembled. Nordstrom plug design gives positive closing and opening with only a quarter-turn—and the plug is permanently seated. You save man-hours and maintain instant control.



Nordstrom Valves

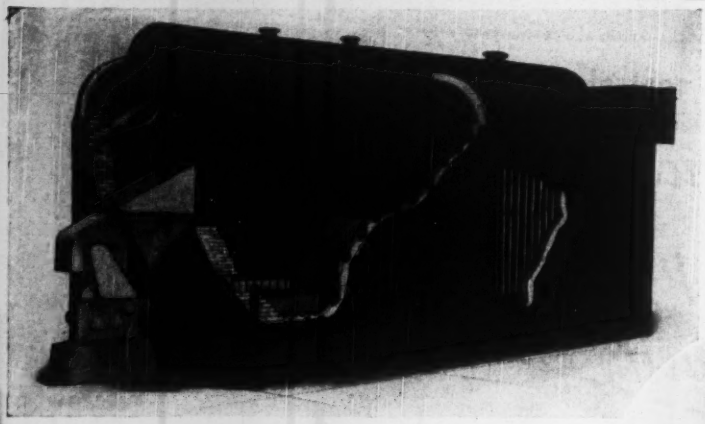
NOW AUTOMATICALLY LUBRICATED WITH Pats. Applied for Hypermatic Trade Mark

***Nordstrom Valve Division*—ROCKWELL MANUFACTURING CO.**
400 North Lexington Avenue, Pittsburgh 8, Pa., Offices in all principal cities

ROCKWELL

Export — Rockwell Mfg. Co., International Division, Empire State Building, New York 1

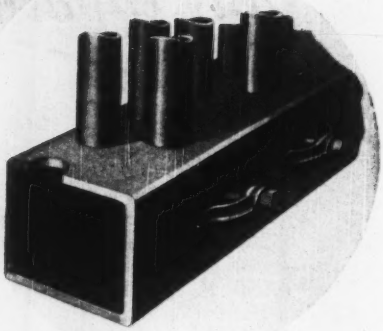
TYPE-VL *A Low Headroom*
2-DRUM WATER WALL BOILER



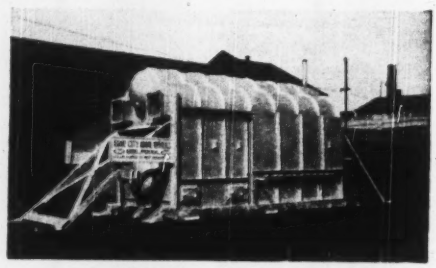
SHIPPED BUILT-UP IN SIZES TO 300 H. P.

Clean, Quiet, Circulating Water Taken From Top Drum

BACKED by a long experience gained in the manufacture of over 500,000 H.P. of Erie City 2-drum water tube boilers and of thousands of complete built-up boiler units, Erie City has incorporated side wall water cooling as an integral part of a low headroom 2-drum boiler. Outstanding of many features, is the method of obtaining a ring flow circulation, in each side wall element. A downcomer tube is provided for each pair of radiant (riser) tubes in the side wall, which, with two front wall downcomers assure an ample supply of clean circulating water in the water walls at all times. Insulation between riser and downcomer tubes keeps water at lower temperature in the downcomers while heat is rapidly removed from refractory through risers. Write for VL bulletin that clearly describes and illustrates this and many other features.



Water Wall tube arrangement—1 Downcomer for each 2 Riser Tubes



Shop assembled and shipped as a unit in sizes to 300 H. P.

COMPLETE STEAM POWER PLANT EQUIPMENT

ERIE CITY

Complete Steam Generators • Type C 3-Drum Boilers • Type VL 2-Drum Boilers • The "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • Coal Pulverizers • Underfeed Stokers and Welded Pressure Vessels for the Process Industries.

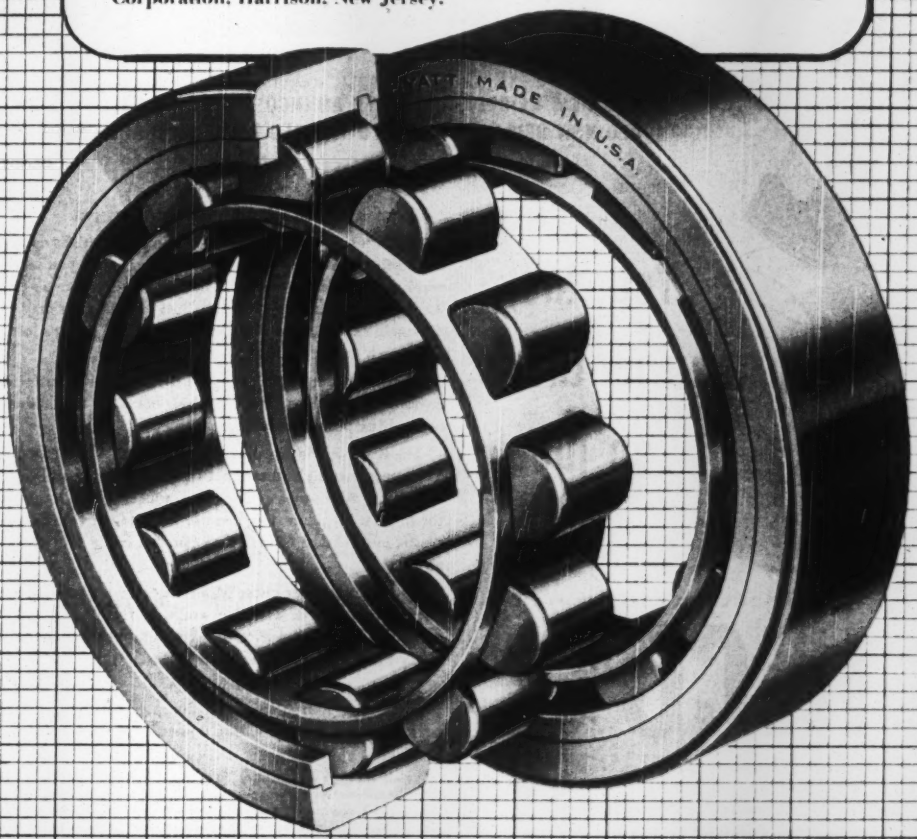
ERIE CITY IRON WORKS • ERIE, PA. • *Since 1840*

Designed in . . . for life

The straight cylindrical construction of Hyatt Roller Bearings permits radial loads carried by the bearing to be evenly distributed over the entire length of the rollers. The larger area of contact between the load carrying elements in straight cylindrical bearings results in greater bearing capacity and longer life with less maintenance.

Size for size, Hyatt Hy-Load Roller Bearings offer maximum radial load carrying capacity. They are "designed in" for the life of your equipment.

To get the most out of the equipment you build, sell or buy, be sure that it is equipped with Hyatt Roller Bearings. Let us tell you more about what we can do for you. Write to Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.



HYATT ROLLER BEARINGS

HERE'S HOW RE-DESIGNING WITH AN INCO NICKEL ALLOY ADDED NEW SELLING POINTS TO THE OLD FAMILIAR DIAPER PIN

You, too, can mother an idea

What's new about a safety pin?

Plenty, if it's a Kwik-Pin . . . a real *safety* pin.

First, consider an ordinary safety pin. Open, it's as dangerous as a fishhook. When you stick it into the diaper, you use two hands, dig down and then up, with a silent prayer that you haven't included the baby. When it's closed, it may pop open unseen (but not always unfelt). When it's lost, you search frantically, for it may be inside the baby.

Now look at the Kwik-Pin and see how this manufacturer re-designed an old product, used Monel wire, and added new selling points to a commonplace item.

The Kwik-Pin is safe open; safe closed. Never can pop open. You can pin straight through 14 layers of diaper and undershirt with an easy, one-hand, squeeze-push action of the fingers. Hygienic, too, because it's made of colorfast plastic and rustless Monel. And you can easily spot it anywhere.

The manufacturer chose Monel because it provided strong, hard, spring-temper wire that would be free of rust and corrosion. Yet, Monel wire was economical enough to let the Kwik-Pin retail at 25¢ per card of 4.

If you're planning a new product, or re-designing an old one, give some thought to the metals that can add extra performance and extra selling points . . . *the Inco Nickel Alloys.*

INCO Nickel Alloys

Monel® • "R"® Monel • "K"® Monel • "KR"® Monel
"S"® Monel • Inconel® • Nickel • "L"® Nickel
Duranickel® • Permanickel®

"Task Metals" for Industry

EMBLEM OF SERVICE

WHAT'S YOUR METAL PROBLEM? *Perhaps, like the Kwik-Pin manufacturer, it's one of wire. Outline your task to us. We'll forward samples of recommended wire for test. Monel and all the Inco Nickel Alloys are the "task metals" of industry . . . ready to help whenever you need tough metals for tough jobs. They're available in all forms.*

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 72 NUMBER 4

Contents for April, 1950

DESCRIPTION OF AN AUTOMATIC DATA-ANALYZING MACHINE	*B. S. Benson*	285
USING SPECIAL MACHINERY TO INCREASE PRODUCTION	*C. A. Nichols*	289
PANELS FOR APPARATUS USED IN COMMUNICATIONS EQUIPMENT	*A. S. Muessen*	295
THE ENGINEER AS A MANAGER	*J. M. Juran*	300
PROGRESS IN RAILWAY MECHANICAL ENGINEERING, 1948–1949		303
HEAT-EXCHANGE EQUIPMENT FOR A 5000-KW GAS-TURBINE GENERATOR	*G. R. Fusner*	316

EDITORIAL	283	REVIEWS OF BOOKS	346
BRIEFING THE RECORD	321	ASME BOILER CODE	350
ASME TECHNICAL DIGEST	335	ENGINEERING PROFESSION, NEWS, NOTES	351
CONTENTS OF ASME TRANSACTIONS	341	ASME NEWS	354
COMMENTS ON PAPERS	342	ASME JUNIOR FORUM	357

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC. 362

BUYER'S CATALOG GUIDE (ADVERTISERS)	41
INDEX TO ADVERTISING PAGES	120

OFFICERS OF THE SOCIETY:

JAMES D. CUNNINGHAM, *President*
J. L. KOPF, *Treasurer* C. E. DAVIES, *Secretary*

PUBLICATIONS STAFF:

GEORGE A. STETSON, *Editor* S. A. TUCKER, *Publications Mgr.*
K. W. CLENDINNING, *Managing Editor* FREDERICK LASK, *Advertising Mgr.*

PUBLICATIONS COMMITTEE:

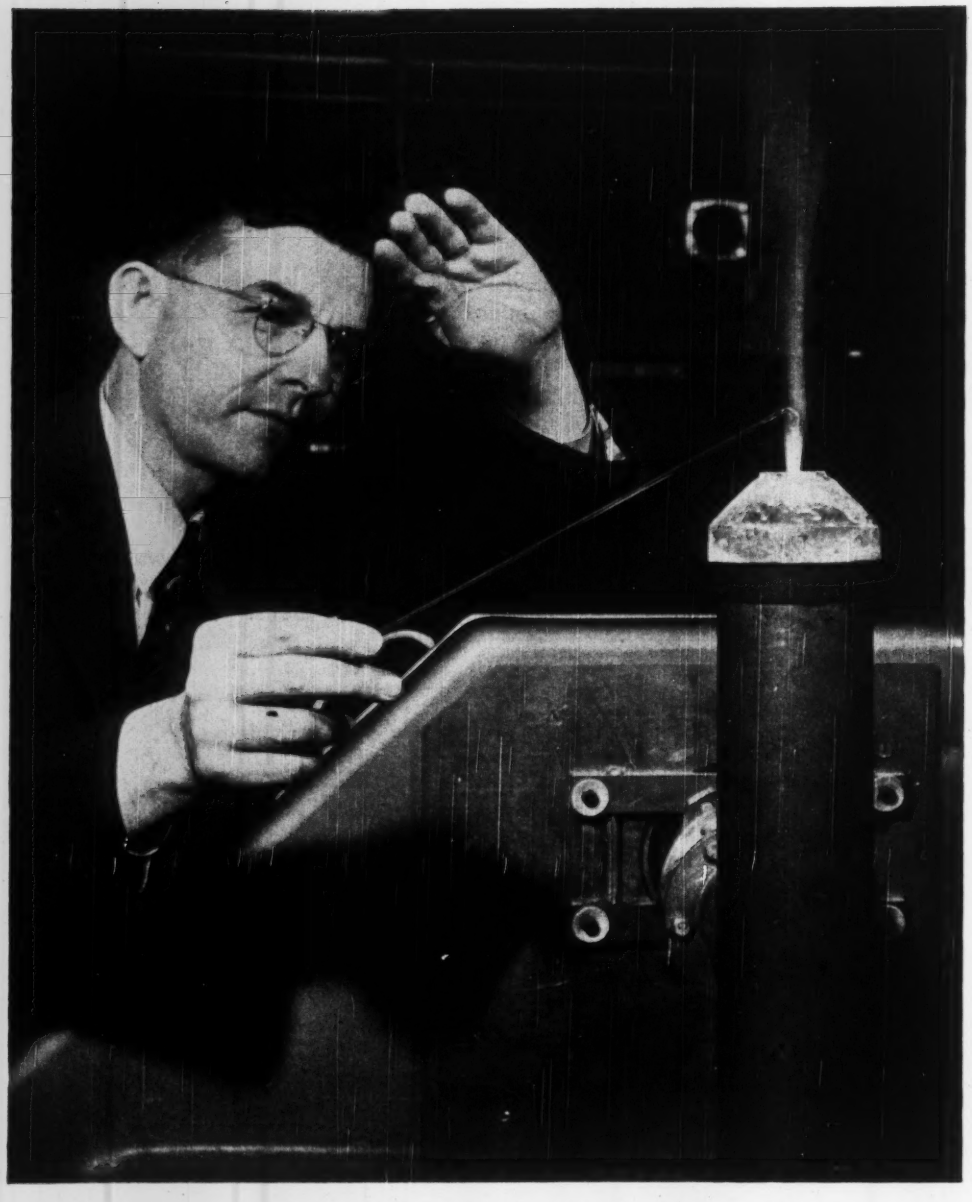
R. B. SMITH, *Chairman*
JOHN HAYDOCK G. R. RICH
C. B. CAMPBELL PAUL T. NORTON, JR.
H. G. WENIG, D. R. THOMAS, *Junior Advisory Members*

REGIONAL ADVISORY BOARD OF THE PUBLICATIONS COMMITTEE

KERR ATKINSON—I
OTTO DE LORENZI—II
W. E. REASER—III
F. C. SMITH—IV
HENDLEY BLACKMON—V
R. E. TURNER—VI
R. G. ROSHONG—VII
M. A. DURLAND—VIII

Published monthly by The American Society of Mechanical Engineers. Publication office at 20th and Northampton Streets, Easton, Pa. Editorial and Advertising departments at the headquarters of the Society, 29 West Thirty-Ninth Street, New York 18, N. Y. Cable address, "Dynamic," New York. Price 75 cents a copy, $7.00 a year, to members and affiliates, 50 cents a copy, $4.00 a year. Postage outside of the United States of America, $1.50 additional. Changes of address must be received at Society headquarters three weeks before they are to be effective on the mailing list. Please send old as well as new address. . . . By-Law: The Society shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B13, Par. 4). . . . Entered as second-class matter at the Post-Office at Easton, Pa., under the Act of March 3, 1879. . . . Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921. . . . Copyrighted, 1950, by The American Society of Mechanical Engineers. Member of the Audit Bureau of Circulations. Reprints from this publication may be made on condition that full credit be given MECHANICAL ENGINEERING and the author, and that date of publication be stated.

MECHANICAL ENGINEERING is indexed by the Engineering Index, Inc.



Electronic Torch Hot Enough to Melt Firebrick and Even Tungsten

(Developed by Dr. J. D. Cobine, scientist of the General Electric Research Laboratory, the flame consists of nitrogen which is passed through a high-frequency arc. Dr. Cobine is shown melting a quartz rod in the flame. The arc is formed by radio waves, at the extremely high frequency of one billion cycles per second, generated by a magnetron tube. The radio waves break up nitrogen molecules—which consist of two atoms—into individual atoms. When these atoms reunite to form molecules again, heat is released. The torch, is still at the laboratory stage of development.)

VOLUME 72
No. 4

MECHANICAL ENGINEERING

APRIL
1950

GEORGE A. STETSON, *Editor*

Have You a Paper to Offer?

IF EVERY member of The American Society of Mechanical Engineers were to write one technical paper for ASME Transactions, it would take about 150 years, at the present publication rate, to print the volume of material that would become available. Such a staggering fact as this leads to a number of obvious generalizations. It is apparent, for example, that the Society would never be able to finance such a publication program; nor could anyone read the material if it were printed. It is equally obvious that even if two or more members collaborate on a single paper, a condition which may be effectively counterbalanced by nonmember authors, the present number of contributors to ASME Transactions is a very small percentage of the entire membership. Authors are relatively rare.

Now it is a well-recognized fact that some engineers are engaged in work where the opportunities of turning up material that should be recorded in the literature are abundant, while others are seldom, if ever, so engaged. It is true also that publication of a technical paper is much more important to some engineers in establishing and maintaining professional recognition, than it is to a majority of engineers. Hence the probability of the Society's being faced with the problem of publishing thousands, rather than hundreds, of papers, is extremely remote.

But even considering all of the foregoing factors and the very impressive volume of technical papers published by the Society, ASME program makers continually ask themselves if there may not exist a number of excellent technical papers, unwritten or unavailable, because the potential authors, even though they may be members, have not thought of presenting the results of their work to their fellow members. Are these unknown authors holding back, waiting to be asked to present a paper? Do they imagine that unsolicited papers are not desired or that they will not be given proper consideration? Is it not possible that some of these unknown papers may be superior to some of those which the Society is now publishing? Might not the ASME technical literature be vastly enriched if the Society had an opportunity to review and publish the papers some of these unknown authors might write?

Serious consideration of these questions poses the problem of finding the answers. A start can be made by making it clear to members that their Society welcomes the opportunity to receive and review contributed papers, that it can advance its own objectives by publishing the best papers its members prepare, and that it is one of the highest privileges of a member to share his special knowledge with his fellow engineers. Only by such means can technical advancement be made on a broad front with maximum efficiency.

ASME has more than forty program-making groups. Although the procedures of these groups are not identical, their objectives are similar—to provide the best material for meetings and publications that can be procured. In some cases these programs are made up principally of contributed papers; in others, papers are solicited. In any event, these groups are composed of competent men working in the fields of their special interests. Papers contributed to or solicited by these groups are subjected to critical review and may be recommended for publication. An earnest effort is made to see that the best papers are published, subject to availability of space and the limitations of human judgment.

The ASME member who wishes to submit a technical paper for presentation and publication should not hesitate to do so. He should convince himself that he has something of value to offer. He should familiarize himself with the principal fields of mechanical engineering to which the Society devotes its attention. In general these fields are represented by the professional divisions and technical committees. He should procure a copy of the Society's pamphlet, "An ASME Paper," in which he will find instructions on writing and offering papers. He should then prepare and submit his paper and have sufficient faith in his fellow engineers to believe that his contribution will be carefully reviewed by competent persons.

Have you a technical paper to offer?

Freedom and Opportunity

TO SOME of us the American way of life is so taken for granted that we fail to appreciate its full value and significance, and we give little thought to the problem of safeguarding it for ourselves and future generations. Hence it is that the testimony of persons born in other lands who have found opportunity and happiness in our way of life has a special significance for us.

Recently at a meeting of the Bridgeport Section of The American Society of Mechanical Engineers one of the speakers, born in Sweden and educated in the elementary schools of that country, paid tribute to the American way of life and touched on a phase, imported from Europe, which disturbs him.

The speaker was Rudolph F. Bannow, president, Bridgeport Machines, Inc., from whose address, "10,000

Milling Machines in 10 Years," the following paragraphs are quoted:

"When we first entered the machine-tool industry, many told us how difficult it would be to get into a field controlled by large monopolistic corporations. May I say here that such nonsense should be discarded by those who still talk that way, as our experience has been that our competitors, big or small, have been helpful and co-operative. They know the rules of the game, they act as good sports, and we have received nothing but congratulations from our competitors in the machine-tool industry; and I am happy to pay this tribute to American industry as a whole.

"Coming to America, many immigrants like myself have succeeded in establishing businesses which would not have been possible in Europe because of the heavy-handed bureaucracy which has its stifling effects on incentive and individual initiative.

"Drawing from my experience abroad as well as here, I am disturbed by the importation of European class struggle to America, which has a basic reason in Europe where the little fellow never counted for many generations, but has no place in America, where all of us, whether immigrants in the past or present, came without any special means, but found opportunity in accordance with our individual initiative and ability. I realize that those who imported the class struggle for political purposes are not conscious of the damage that they have done by splitting the people of America into hostile groups; and unless we can reverse this trend and make everyone realize that the best interest of employers and employees lies in working together and understanding each other's problems, we stand a good chance of winding up in the same position in which Europe now is. America will then cease to be known as the land of freedom and opportunity."

What Do You Want?

THE periodic check on what readers think about MECHANICAL ENGINEERING is now underway. The method used, as in the past, is to send out every month for a limited period a letter soliciting co-operation in the scheme and a return card on which the reader can check features he likes, list articles that appeal to him, and offer suggestions and comments. A relatively small number of readers are appealed to every month. The names are chosen in a manner which should result in a representative cross section of readership. The results are carefully analyzed and studied and will be subject to comment in a later issue.

If you are one of the few readers to be asked for your opinion in the coming months, may we urge you to take the request seriously. If you do, you will help the Publications Committee and the editorial staff. But you do not have to wait to be asked for your views. You have the magazine before you now. Why not examine it critically and let us have the benefit of your comments and suggestions? Let us know what you want your magazine to do for you.

Help Others to Understand

FOR many years the ASME Engineers Civic Responsibility Committee has been engaged in arousing engineers to a realization of the obligations of citizenship and in urging them to do something about it. One of the Committee's advisory members, Leonard J. Fletcher, director of Training and Community Relations, Caterpillar Tractor Company, has spoken at numerous meetings of The American Society of Mechanical Engineers both on behalf of the Committee and in support of its program.

On invitation Mr. Fletcher has prepared a direct appeal to engineers to make their citizenship more effective by spreading the spirit of understanding to the important daily contacts of their lives. Mr. Fletcher writes:

"As technically trained men of action, engineers serve society. But this service can be rendered effectively only in a nation of free and understanding people. Where the thinking of a nation is confined to and directed solely by a group of power-seeking social and political planners, engineers are forced into prisons of fantastic and impossible demands and schemes. Most of the factors of production, which engineers in a free economy control or reasonably influence, are, in an economy that is not free, rigidly outlined and enforced by others. The engineer is 'only' required to get results, to the end that, no results, no engineer.

"True, people do not deliberately and knowingly dig their own economic graves. But masters of propaganda can, and do, employ the well-known hopes, desires, and prejudices of the individual to entice him into building what he thinks will be his house of joy, only to find upon its completion that it is his tomb.

"So here is the challenge to our profession—to the individual engineer. We must use every opportunity in our daily contacts with others to develop real understanding of how we live together and serve one another. Show, patiently and with tolerance for the hopes and views of others, that we cannot have more than we produce; that we must *give* before we *get*. Show the 'machine' as a servant of man, not his master. Acquaint yourself with the facts concerning the distribution of national income. Learn the proportion of this income now paid to wage earners and those who are self-employed. Learn the comparative amounts created as profits by American business and industry, and how these profits are employed for the benefit of society. Establish clearly the place and function of the free buyer in our competitive economy, and how he is the principal factor in determining whether businesses grow or perish. Get the facts concerning the interdependence of large and small businesses. Get the picture of how those in other lands live. Determine what they can buy with an hour of their labor, and see if you will not agree with the statement that in this country we live at a high level with an occasional boom.

"Establish the facts. Discuss them with others. Help others to understand."

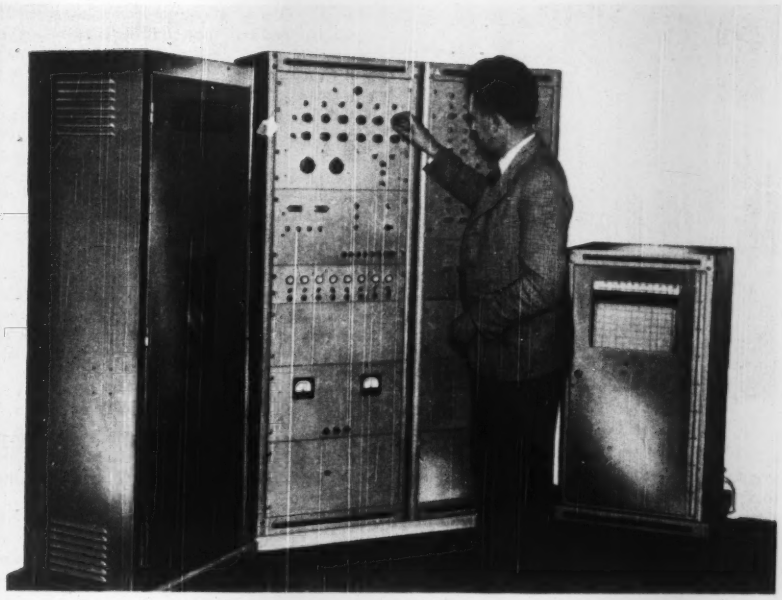


FIG. 1 AUTOMATIC BAR-GRAPH ANALYZING MACHINE

Description of an AUTOMATIC DATA-ANALYZING MACHINE

By B. S. BENSON

RESEARCH ENGINEER, DOUGLAS AIRCRAFT COMPANY, INC., SANTA MONICA, CALIF.

INTRODUCTION

DURING recent years, great advances have been made in the art of collecting and recording data relating to physical phenomena. A wealth of information is steadily accumulating in many fields, notably aeronautics, where wind-tunnel tests, airplane and missile flights are producing vast quantities of experimental data. The significance of much of the information is often hidden, as the records are usually in code, scrambled and uncalibrated, in a form most suitable for the recording equipment; this is particularly true where a radio link connects the instruments to the recorder. The task of deciphering such records, applying the necessary computations, and presenting the results in a graphic form suitable for direct reference, or in electrical-impulse form suitable for assimilation into automatic computers, is extremely laborious. In the past, much of the recorded material has been left unused, or has not been made available in time to be of direct value; in short, work in the field of data reduction has not kept abreast of developments in data collection. There has been a growing need for the development of automatic equipment to relieve this bottleneck.

The function of an automatic analyzer may be broken down into two main parts, (1) that involving the assimilation and decoding of the data from their original recorded form; (2) the application of routine computations. These latter are necessary for calibration purposes if the analyzer is required to yield a graphic output, and often desirable even if the data are merely to be fed directly into another automatic calculating machine for correlation with material from other sources.

MACHINE FOR ANALYZING BAR GRAPH RECORDS

The author's company has found it necessary to develop several machines for expediting data analysis and performing specialized computations. One of these, here described and illustrated in Fig. 1, has been designed and built for the automatic analysis of bar-graph records. Such recordings, in which each

Contributed by the Industrial Instruments and Regulators Division and Aviation Division and presented at the Annual Meeting New York, N. Y., November 27–December 2, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Milling Machines in 10 Years," the following paragraphs are quoted:

"When we first entered the machine-tool industry, many told us how difficult it would be to get into a field controlled by large monopolistic corporations. May I say here that such nonsense should be discarded by those who still talk that way, as our experience has been that our competitors, big or small, have been helpful and co-operative. They know the rules of the game, they act as good sports, and we have received nothing but congratulations from our competitors in the machine-tool industry; and I am happy to pay this tribute to American industry as a whole.

"Coming to America, many immigrants like myself have succeeded in establishing businesses which would not have been possible in Europe because of the heavy-handed bureaucracy which has its stifling effects on incentive and individual initiative.

"Drawing from my experience abroad as well as here, I am disturbed by the importation of European class struggle to America, which has a basic reason in Europe where the little fellow never counted for many generations, but has no place in America, where all of us, whether immigrants in the past or present, came without any special means, but found opportunity in accordance with our individual initiative and ability. I realize that those who imported the class struggle for political purposes are not conscious of the damage that they have done by splitting the people of America into hostile groups; and unless we can reverse this trend and make everyone realize that the best interest of employers and employees lies in working together and understanding each other's problems, we stand a good chance of winding up in the same position in which Europe now is. America will then cease to be known as the land of freedom and opportunity."

What Do You Want?

THE periodic check on what readers think about MECHANICAL ENGINEERING is now underway. The method used, as in the past, is to send out every month for a limited period a letter soliciting co-operation in the scheme and a return card on which the reader can check features he likes, list articles that appeal to him, and offer suggestions and comments. A relatively small number of readers are appealed to every month. The names are chosen in a manner which should result in a representative cross section of readership. The results are carefully analyzed and studied and will be subject to comment in a later issue.

If you are one of the few readers to be asked for your opinion in the coming months, may we urge you to take the request seriously. If you do, you will help the Publications Committee and the editorial staff. But you do not have to wait to be asked for your views. You have the magazine before you now. Why not examine it critically and let us have the benefit of your comments and suggestions? Let us know what you want your magazine to do for you.

Help Others to Understand

FOR many years the ASME Engineers Civic Responsibility Committee has been engaged in arousing engineers to a realization of the obligations of citizenship and in urging them to do something about it. One of the Committee's advisory members, Leonard J. Fletcher, director of Training and Community Relations, Caterpillar Tractor Company, has spoken at numerous meetings of The American Society of Mechanical Engineers both on behalf of the Committee and in support of its program.

On invitation Mr. Fletcher has prepared a direct appeal to engineers to make their citizenship more effective by spreading the spirit of understanding to the important daily contacts of their lives. Mr. Fletcher writes:

"As technically trained men of action, engineers serve society. But this service can be rendered effectively only in a nation of free and understanding people. Where the thinking of a nation is confined to and directed solely by a group of power-seeking social and political planners, engineers are forced into prisons of fantastic and impossible demands and schemes. Most of the factors of production, which engineers in a free economy control or reasonably influence, are, in an economy that is not free, rigidly outlined and enforced by others. The engineer is 'only' required to get results, to the end that, no results, no engineer.

"True, people do not deliberately and knowingly dig their own economic graves. But masters of propaganda can, and do, employ the well-known hopes, desires, and prejudices of the individual to entice him into building what he thinks will be his house of joy, only to find upon its completion that it is his tomb.

"So here is the challenge to our profession—to the individual engineer. We must use every opportunity in our daily contacts with others to develop real understanding of how we live together and serve one another. Show, patiently and with tolerance for the hopes and views of others, that we cannot have more than we produce; that we must *give* before we *get*. Show the 'machine' as a servant of man, not his master. Acquaint yourself with the facts concerning the distribution of national income. Learn the proportion of this income now paid to wage earners and those who are self-employed. Learn the comparative amounts created as profits by American business and industry, and how these profits are employed for the benefit of society. Establish clearly the place and function of the free buyer in our competitive economy, and how he is the principal factor in determining whether businesses grow or perish. Get the facts concerning the interdependence of large and small businesses. Get the picture of how those in other lands live. Determine what they can buy with an hour of their labor, and see if you will not agree with the statement that in this country we live at a high level with an occasional boom.

"Establish the facts. Discuss them with others. Help others to understand."

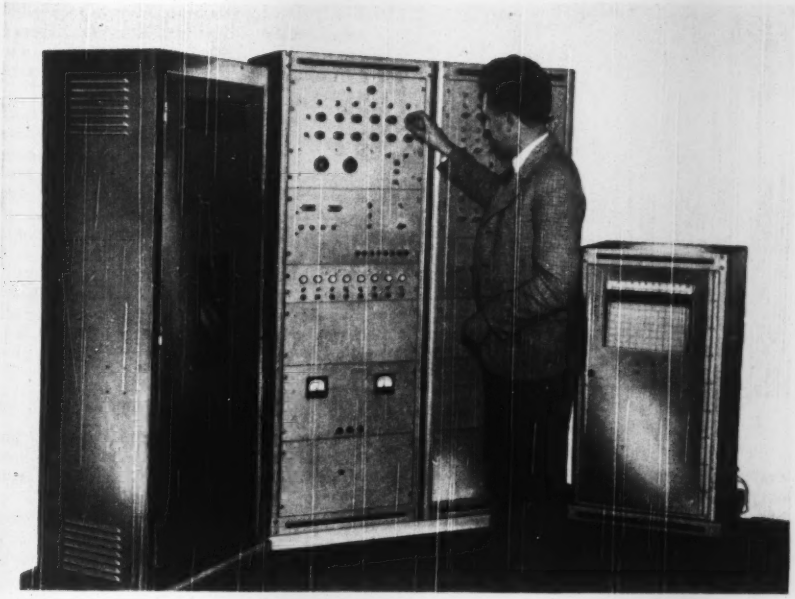


FIG. 1 AUTOMATIC BAR-GRAPH ANALYZING MACHINE

Description of an AUTOMATIC DATA-ANALYZING MACHINE

By B. S. BENSON

RESEARCH ENGINEER, DOUGLAS AIRCRAFT COMPANY, INC., SANTA MONICA, CALIF.

INTRODUCTION

DURING recent years, great advances have been made in the art of collecting and recording data relating to physical phenomena. A wealth of information is steadily accumulating in many fields, notably aeronautics, where wind-tunnel tests, airplane and missile flights are producing vast quantities of experimental data. The significance of much of the information is often hidden, as the records are usually in code, scrambled and uncalibrated, in a form most suitable for the recording equipment; this is particularly true where a radio link connects the instruments to the recorder. The task of deciphering such records, applying the necessary computations, and presenting the results in a graphic form suitable for direct reference, or in electrical-impulse form suitable for assimilation into automatic computers, is extremely laborious. In the past, much of the recorded material has been left unused, or has not been made available in time to be of direct value; in short, work in the field of data reduction has not kept abreast of developments in data collection. There has been a growing need for the development of automatic equipment to relieve this bottleneck.

The function of an automatic analyzer may be broken down into two main parts, (1) that involving the assimilation and decoding of the data from their original recorded form; (2) the application of routine computations. These latter are necessary for calibration purposes if the analyzer is required to yield a graphic output, and often desirable even if the data are merely to be fed directly into another automatic calculating machine for correlation with material from other sources.

MACHINE FOR ANALYZING BAR-GRAPH RECORDS

The author's company has found it necessary to develop several machines for expediting data analysis and performing specialized computations. One of these, here described and illustrated in Fig. 1, has been designed and built for the automatic analysis of bar-graph records. Such recordings, in which each

Contributed by the Industrial Instruments and Regulators Division and Aviation Division and presented at the Annual Meeting New York, N. Y., November 27–December 2, 1949 of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

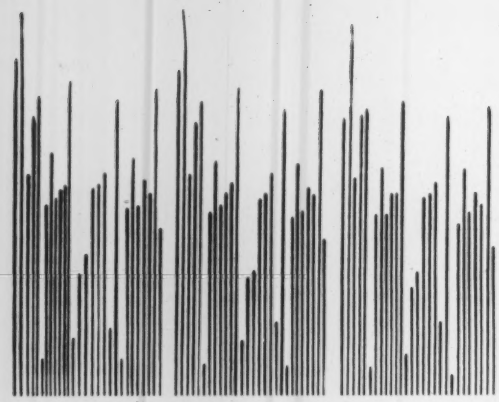


FIG. 2 SAMPLE RECORDING

discrete value is represented by the length of a line, are obtained, for example, from photographic records of banks of manometer tubes. A similar record is made by a telemetry system developed by Project Hermes,[1] and used in conjunction with an Army Ordnance missile project, under contract to the Bell Telephone Laboratories and Douglas Aircraft Company on which the machine was built.

The telemetry system transmits information on the performance of missile-borne instruments and records it at a ground station in the form of hundreds of thousands of lines. To interpret the information, the length of each line has to be measured and the values calibrated and plotted to suitable scales. When work of this nature is done manually, progress is slow, and the personnel problems are severe; the task is very monotonous, and a high degree of accuracy is essential. In the case of the analysis of missile-telemetry data, it is often essential to evaluate an appreciable amount of recorded information before firing a subsequent missile, and, as the cost of interruptions of a firing program is prohibitive, the time element is extremely important.

The machine here described has been in use for about a year, for the most part analyzing data recorded by the Hermes system; this application will be used as a basis on which to describe the machine and its operation.

The pulse-time telemetering system transmits 28 channels of information. The transmitted signals, representing the readings from 28 instruments in the missile, are received and recorded by ground stations. Photographic 35-mm film is driven continuously in a camera which thus records the motion of a light spot appearing on a cathode-ray tube. The information is presented on the film as frame groups of 28 parallel straight lines of varying lengths, each about 0.004 in. wide. The length of each line represents the output of a particular instrument at a particular time. About 32 such frames are recorded every second, hence some hundreds of thousands of lines are recorded from any one flight. Fig. 2 shows a sample of a recording.

The automatic analyzing machine plots calibrated values of instrument measurements against time. A complete measuring cycle, resulting in one plotted point, involves counting progressively through a frame to locate the required line, measuring its length, and plotting the value after suitable modification by preset zero and scale factors. About 40 points are plotted per min with an accuracy better than $\pm \frac{1}{2}$ per cent of full scale deflection.

This development is an interesting example of the growing trend to design machines to replace the human operator in certain simple but tedious thinking operations, as compared to the more familiar field of automatic processing machines. In the example described in this paper, the task involves in all about 14 quantitative memories for calibration purposes, and about 5 distinct sequential thought patterns for selecting lines, controlling measuring cycles, etc.; some 5 discriminative thought patterns are involved to detect errors. It is evident that such a limited combination represents a relatively low level of intelligence compared to the human brain, yet because of the perseverance and uniform accuracy of the machine, it surpasses its human counterpart in the performance of its specialized task.

ELEMENTS OF THE MACHINE

The machine comprises essentially a film projector and a screen associated with a photoelectric cell, counting circuits to determine the location of selected lines, and measuring networks to determine and record their lengths.

Fig. 3 shows the optical cabinet of the automatic analyzer, and Fig. 4 the film drive and projection unit in greater detail. The film-drive mechanism is operated by a synchronous motor capable of achieving full speed from rest in $\frac{1}{120}$ sec or coming to a stop in an equally short time. At the command of the counting circuits, this precise film drive brings each required line into position for measuring purposes. This is illustrated in the block diagram shown in Fig. 5. The image of the film is

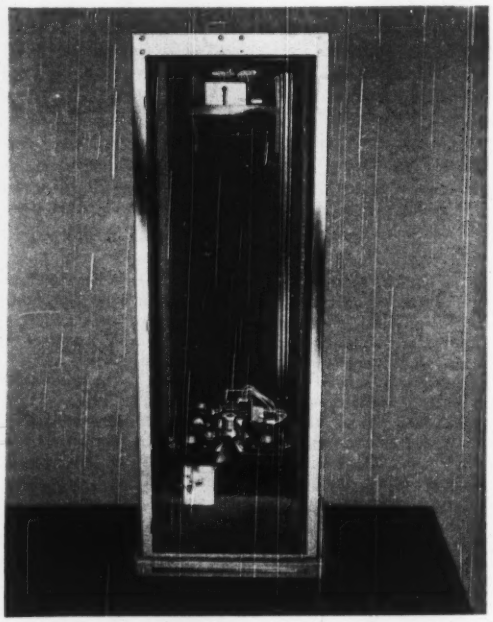


FIG. 3 OPTICAL CABINET OF ANALYZER

[1] "Telemetry for Guided Missiles," by L. J. Neelands and W. Hausz, Proceedings National Electronics Conference, vol. 3, 1948, also in Radio Electronic Engineering issue of *Radio News*, vol. 10, January, 1948, pp. 3-6.

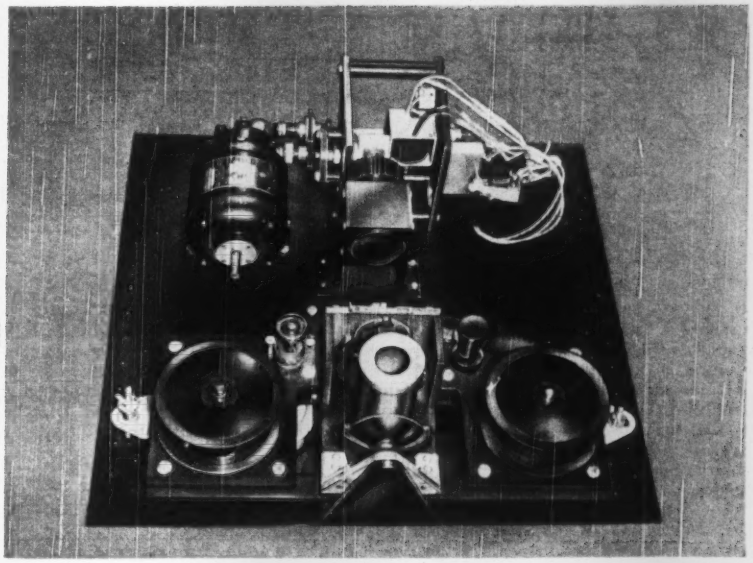


FIG. 4 FILM-DRIVE AND PROJECTION UNIT

projected through a lens of 4-in. focal length; a first surface mirror deflects the path through 90 deg and projects the image onto a monitoring screen. A $^1/_8$-in. × 0.002-in. slit in the center of the screen allows a spot of the image to be viewed by a nine-stage multiplier phototube mounted in an otherwise light-sealed box behind the screen.

When the film drive is in operation, the photocell sees alternately dark and light as the bases of the lines are swept past the aperture. The impulses thus produced serve to actuate a stepping relay which has effectively 28 positions. As the image of each line is sensed by the photocell, the relay advances one step; and therefore maintains synchronism with the passage of the lines past the window, restarting its cycle at the beginning of each successive frame.

Twenty-eight switches are provided on a control panel, each one wired to a contact on the stepping switch. Any switch circuit which is closed causes the film-drive motor to stop the film when the corresponding line is in position, and the scanning and measuring sequence to take place. The selection of the switches thus determines the lines to be measured in the frame.

The line is scanned by tilting the pivoted mirror and thus deflecting the projected image past the window. A cam is driven through a clutch by a motor, and its follower rotates the mirror through an angle of about $6^1/_2$ deg and back to its original position once for every cycle of the cam. A solenoid is actuated to free the camshaft each time the mirror is required to scan a line.

A precision potentiometer is connected to the mirror camshaft to give an electrical indication of mirror angle. A memory condenser is charged by the scan potentiometer and transmits the value through a cathode follower circuit to a recording potentiometer. When a line is being scanned, the photocell senses the transition from dark to light as the end of the line passes the window, and this cutoff signal serves to isolate the potentiometer from the memory condenser, which therefore remembers a value proportional to the length of the measured line. No attempt is made to stop the mirror when the end of the line is reached, as the inertia problems would jeopardize the accuracy of the measurement; the scan is therefore arrested electrically, while mechanically it is allowed to continue to the full extent of the film width.

When the scan has been completed, the machine restarts the counting sequence, seeking the next line which it will be required to measure. In the meantime the recording potentiometer seeks its balanced position and plots a point representing the measured value modified by preset calibrations.

Six independent calibration networks are provided, each one may be assigned to a specific line in the frame and is brought into play when the particular line is being measured. These adjustable resistor networks are initially set for each run so that the individual plots may be displaced suitably on the ordinate scale and spread over a particular required chart width. In this way several curves may be plotted on one sheet for purposes of correlation, each with individual scales to facilitate direct reading in convenient units on the paper. For example, if a full-length line represented an instrument reading of 850 lb, such a value when plotted would be made to appear 8.5 squares away from a preselected zero.

CHECKING CIRCUIT TO DETECT DISTORTIONS OF RADIO SIGNAL

Distortions of the radio signal can at times induce spurious marks or other telemetry faults. To be fully automatic, the machine must be able to detect such flaws. For this purpose, a checking circuit is provided, involving a lagged relay which is de-energized every time the photocell detects a space between lines, but releasing only during the longer intervals which occur between frames. The position of the interframe space thus detected is checked against the position of the line-counting relay. When a fault is located, the machine responds in a predetermined pattern, either awaiting further instructions or continuing operation after correcting the counting sequence.

In normal operation where telemetry records are being an-

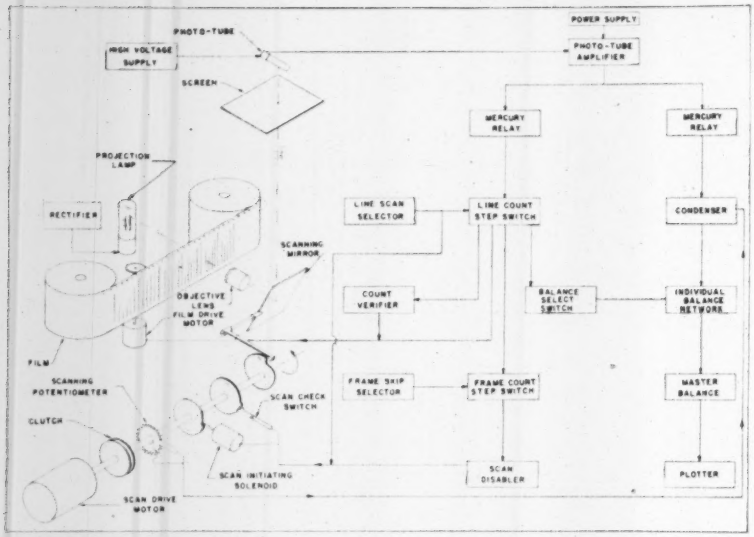


FIG. 5 BLOCK DIAGRAM SHOWING OPERATION OF ANALYZER

alyzed, it has been found convenient to plot six channels during one passage of the film through the machine; in this case the points are printed sequentially in six different colors so that each trace is identified by one color throughout. Precautions are taken to insure that the color assignments do not become interchanged if a faulty count in a frame disturbs the normal plotting sequence. A circuit verifies that the first point in each frame is printed in the first color in the sequence of six, or whichever number is being used. Should a fault occur, the machine automatically stops, reorientates the colored printing wheel, and continues in correct sequence.

The length of certain lines which record calibration information may be checked automatically for variations from preset limits by microswitches mounted on the recorder, which verify the position of the printer when certain assigned channels are being read. The machine will stop automatically if these values drift or fluctuate beyond preset limits, giving the operator an opportunity to make any necessary adjustments. For this purpose, over all zero and sensitivity adjustments are provided which affect all of the readings being made as against the individual adjustments, which are applied only to specific channels.

The paper drive on the recorder is controlled by a solenoid which advances the paper by a preselected increment each time a point a plotted. A continuously variable gear provides a means to correct for variations in the speed of the missile-borne commutator which causes variations in the number of frames recorded per second. Thus proper time correlation may be maintained, so that regular increments of time on the record are represented by discrete squares on the paper.

COST OF AUTOMATIC DATA ANALYSIS

An experienced operator requires about 15 min to adjust the machine to read a particular record, so that each of six channels is plotted to a prescribed scale. Thereafter little supervision is required if the film is of moderately good quality. In order to assess the financial saving afforded by such automatic data analysis, cost investigations were made recently, comparing the time required to analyze automatically the telemetry records from a V-2 flight with the costs of manual data reduction for a similar task before the machine was built. A man-hour ratio of more than 5:1 in favor of the automatic method showed a comparative saving of over $9000 for a single record. With such a saving, the original cost of the machine is amortized in a few rounds.

The reliability of an automatic device is an important factor influencing its usefulness; in this connection it is interesting to note that while from time to time improvements have been incorporated in the machine, the actual maintenance required has been negligible.

Several elaborations of the present device are envisaged for future models, such as the provision of an electrical impulse output suitable for direct application to automatic calculators. Many other variations are foreseen which would increase the scope of the device but which were not required for the particular application for which this machine was designed.

CONCLUSION

In conclusion, it is interesting to note that much of the need for the device described stems from the fact that instruments usually speak different languages from calculating machines, both of which may be foreign to our own speech and thoughts. From this situation grows the need for coding and interpreting devices which in many fields are in a less advanced stage of development than the instruments and calculators themselves. Involved calculations which take seconds to perform by modern electronic computers are often preceded by weeks of tedious coding to tell the machine what the operators want done, and followed by laborious processes of translating the output of the machine into an intelligible form.

Here is a fascinating field, many aspects of which have been dramatically highlighted by Dr. Vannevar Bush.[2]

[2] "As We May Think," by Dr. Vannevar Bush, *Atlantic*, July, 1945, and *Life*, September 10, 1945.

Using SPECIAL MACHINERY *to Increase* PRODUCTION

Quality of Products Improved and Costs Reduced

By C. A. NICHOLS

MASTER MECHANIC, DELCO-REMY DIVISION, GENERAL MOTORS CORPORATION, ANDERSON, IND.

OVER a period of 30 years, the author has gained wide experience in the application of special machinery in a plant manufacturing automotive electrical equipment. During that time about 850 special machines have been placed in service. Two hundred different designs have been involved, and the total value of the equipment was approximately $5,000,000.

During this time the method of approach has changed from the mechanical-wizard method to the use of a complete development organization. Many new materials and facilities have come into use which have aided the designer, but which have required a wider knowledge to permit their use. Among these materials and facilities are tungsten carbide, alloy steels, improved bearings, hydraulic and electrical devices.

The classification of a machine as "special" depends upon whether it is being used in a plant where such equipment is not normally required, but where it has been found particularly suitable to perform an essential operation. In another plant, where such equipment is a regular production machine, it would not be considered as "special." An example of this might be the use of a thread-rolling machine for knurling a shaft for a small motor. Such a machine would be considered standard in a plant making screws, but would be thought of as special in the motor plant.

A standard machine may be tooled so that in effect it is a special machine. As an example, a milling machine was tooled to cut circular teeth in a file. The teeth in the face mill were set in a spiral, each tooth being of a different height. Each rotation of the cutter broached one finished tooth. The standard milling machine became a special broaching machine.

For purposes of this discussion a special machine may be defined as "equipment for performing one or more operations on a product where no machines are available on the open market." Automatic screw machines, cold headers, centerless grinders, and the like, are standard machines. An automatic cycling machine for undercutting micas in small commutators would be special, since there is no such machine available on the market, although standard machines for hand operation can be purchased.

WHEN IS SPECIAL MACHINERY JUSTIFIED?

Special machinery is justified, if its use increases quality, lowers cost, or reduces fatigue. Almost invariably two or more of these results are achieved. Although the primary objective may be the reduction of cost, it is usually found that the quality of the product is improved. This is especially true in the use of automatic machinery. The successful operation of such equipment depends upon the uniformity of the material or parts fed to the machine. It is often necessary to make an improvement in these parts or the material to achieve success with the special equipment. This does not always lead to increased cost, since a study of the variation in the material prior to the special tooling frequently will lead to possible improvement either at no cost, or an additional saving. It is almost axiomatic that special equipment, usually of a semi-automatic nature, will improve quality because of its tendency to reproduce faithfully a cycle of operations and act as an inspection device.

Automatic inspection is frequently incorporated in a special machine. These devices may be used in such a manner that defective pieces may be ejected or the machine may be stopped. On more complicated equipment, signaling devices can be incorporated which will indicate the location of the trouble. This enables the operator to get the machine back into operation with minimum lost time.

FACTORS RELATING TO SUCCESS OF SPECIAL MACHINES

The successful use of special machinery is not contingent alone upon its sound design and careful construction. There are four important factors which must exist within the plant before there is any chance of special machinery proving successful. The first of these involves management. Only under optimistic and patient management is it possible to acquire and use special machinery. Since the equipment is special it is not possible to see the identical machine in operation in some other plant. An optimistic manager will be aware that any special machine will have more faults than a standard machine, since it is generally the first one of its kind. If he has confidence in his organization, he will know that any faults which may develop will be rectified.

An optimistic manager will contribute greatly to the enthusiasm of those who are responsible for special machinery. His leadership can so inspire the group that extraordinary accomplishments are possible.

Optimism must be followed with reasonable patience. Any machine will work on paper. No special machine will operate successfully just as soon as final assembly is completed. It is not abnormal for 20 per cent of the final cost of a machine, designed and built by a capable organization, to be expended after the machine apparently has been completed. This fact must be recognized by management. The optimism and patience of management should be based upon having capable tool- and machine-maintenance personnel available. Without this type of personnel no continued successful use of special equipment is possible.

A properly built and processed machine with a trained operator will produce anywhere it happens to be located for a while. The first time there is trouble and unskilled help attempts to rectify it, the machine will begin to be a source of trouble.

Contributed by the Machine Design Division and presented at the Annual Meeting, New York, N. Y., November 27–December 2, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Skilled help for maintenance is most important if hydraulic or electronic equipment is involved, although any machine will depreciate rapidly and fail to perform properly if normal repairs, adjustments, and lubrication are not carried out faithfully. Increased use of special machinery usually results in a percentage increase in the number of tool and maintenance men, and, if much labor saving is made, an increase in the per cent of plant overhead. This must be evaluated from the standpoint of the total effect on cost.

The successful use of special equipment is influenced by the attitude of production supervisors. If their co-operation can be secured, the possibility of successful operation is vastly increased. Such co-operation will be forthcoming if real efforts are made to convince them from the start that their interests are being considered.

Supervisors and foremen should be present at design meetings, and their suggestions and opinions given careful consideration. If they realize that the machines are designed and built for them, and that the success of the venture will reflect their supervisory abilities, the path to efficient operation will be much smoother.

Along with co-operative supervision, operator training is essential. A plant having a good training system can avoid many of the difficulties which may occur when new equipment is being placed in operation. The first requirement is a training supervisor who has a production viewpoint rather than that of the machine builder.

If possible the machines should not be placed in the production department during operator training, but should be in a separate area devoted to such work. This prevents the operator from being exposed to outside influence, contributes to his sense of importance, and lessens his nervousness when learning a new job. Suggestions as to location and ease of controls, location of raw and finished stock containers, etc., should be solicited and given very careful consideration. Properly treated as an important individual, the operator will often show as much pride in the finished machine as its designer and builder.

The continued use of the operators initially trained to use the equipment may not be possible, but once the methods and production standards are set, it is the duty of production supervision to see that they are continued. If the machines are serviced properly and other conditions do not change, the precedent once established is not difficult to maintain.

Given assurance that organization factors are favorable to the success of special machines, it is then necessary to determine which production jobs should be considered for the application of special equipment.

The proper selection of projects to develop should be governed by the value of the result. With a limited budget, as usually is the case, projects should be chosen with care to be assured that the expenditure yields the best possible return.

Hence it is important that a cost estimate be made even before proceeding with the design. At this stage, a conference for the benefit of the cost estimator is helpful. The group should include representatives of production supervision, product engineering, plant layout, tool- and machine-building supervision, machine design, and cost accounting.

PLANNING MACHINE REQUIREMENTS

Present Production Schedule and Possible Schedule Changes. Due to seasonal demands or other causes, the immediate schedule may be high or low. One of the basic facts for the program is the maximum production to be required, and the number of daily hours that will be available for this schedule.

Actual Present Production Rate. This figure might be assumed to be so apparent as to require no check. However, a careful study of the actual production possibility of the present method may show that the rate is or could be considerably different from what is generally recorded or accepted. The actual rate of production may be lower than it is thought to be, but combined with other operations in the department may show a good departmental efficiency, even though this one machine may be unable to produce at the rated standard. On the other hand, the machine might be producing at a higher rate and aiding in carrying other inefficient equipment. Relatively inexpensive changes may make it possible to produce at a higher rate. The proposed new equipment should be compared to the best possible performane of the present method.

How Long Will Model Remain in Production? Checks with sales and engineering departments will show whether there will be sufficient total production to be certain that the cost of the equipment will be amortized before it becomes obsolete.

Changes in Model That Might Be Made at Time of Retooling. When considerable expenditure is being made for new equipment, it is wise for sales and engineering to study the model for desirable changes and improvements which might improve the quality of the product with possible additional savings. The proposal to change a method of manufacturing may stimulate the imagination of the product designer, causing him to think of possible changes which had not previously been under consideration. Often minor concessions by engineering will simplify the special machine.

Adaptability of Machine to Future Model Changes. It may be possible to design the machine so that it does not restrict too seriously the possibility of producing similar pieces of different size or design. This should be given thorough study, otherwise minor product design changes might be impossible without obsoleting expensive production facilities. Where there is complete assurance that there will be no changes over a long period, the cost of the machine may be kept lower by not making it universal.

Required Rate of Machine. This is dictated primarily by the number of pieces to be produced per day. It may be fixed by the production rate of a balanced line. There would be no value in producing more pieces than are fed to it by preceding machines or can be used by machines following it, unless it is possible for an operator to operate some other machine as well. If the machine is not in a balanced lineup, the production rate may be determined by the cost of the equipment. Very expensive machines may be operated more hours per day to keep down the investment. If multiple machines are required, it may be possible to operate more than one per operator, and this might be profitable even though the productive rate per machine is lowered.

Skilled or General Classification Operators Required. The type of operator required may determine the hourly rate to be paid. This is a factor in the potential saving of the machine.

Cost of Special Machine. This should include the cost of designing, building, and bugging. The most difficult part of the estimate is the latter. It may run from 10 to 100 per cent over the cost of building the machine originally. A fair average figure would be about 20 per cent.

Effect on Preceding or Subsequent Operations. Very often the use of a special machine to perform an operation will be affected by the condition of the parts fed to it to such an extent that improvement or changes might be required in the preceding machines. This may affect the saving adversely or lead to further cost reduction. Generally, the necessary improvements in the parts to be processed in automatic machines would have been as desirable and profitable for hand operation. In the manufacture of automotive generators the use of automatic lead-connecting machines forced an improvement in the commutator-notching operation. Although this was not con-

templated initially, new machines developed for this purpose gave the required improvement and proved to be a profitable investment.

Changes in Plant Layout, Ventilation, and Utilities Distribution. The cost of installation, conveyers, ventilation, and improved facilities such as transformer capacity, power, air, gas and water lines, are costs which may be incurred in the use of special machinery and should be included for the purpose of calculating return on investment.

Disposition of Replaced Equipment. The salvage value of the replaced equipment may be credited to the savings of the new method.

Effect on Material Cost. The new method may change the amount of material required per piece, or may change its specification. If the use of a more costly material is required for the successful performance of automatic equipment, the additional cost may nullify other savings.

Percentage of Rejects. The scrap or reoperation cost is often of importance in the justification of special equipment.

Effect on Plant Overhead. The following items affect plant overhead:

(*a*) *Perishable Tools and Nonproductive Materials:* Often a part of the saving may be nullified by ignoring the cost of tools and nonproductive materials required by the new method.

(*b*) *Cost of Utilities:* Power, steam, gas, and air may be important factors in the cost of operation and should be checked when an estimate is being prepared. It may cost as much for an air blast to eject pieces as it does for labor to operate a machine.

(*c*) *Cost of Machine and Tool Maintenance:* These items should be included in the cost. They may go either way, but on the average the machine-maintenance cost will increase if the equipment has increased in complexity.

(*d*) *Depreciation:* The changed capital investment will alter the annual charges for depreciation.

(*e*) *Effect of Reduced Labor Cost:* If the machine is to be built on a labor-saving basis, the plant burden will be increased since all other costs are prorated against a lower labor cost. Management should be prepared for an increase in percentage overhead if extensive use of special machines for labor savings is followed.

The foregoing factors properly evaluated and tabulated will show whether the special machine is a worth-while investment. This estimate should be checked periodically during the design phase to determine whether further check will alter the figures.

DECIDING WHO WILL DESIGN THE MACHINE

Once it has been decided that a special machine offers good investment possibilities, a choice of method for designing and building must be made. The facilities available inside the plant will determine whether the equipment will be designed and built inside or outside of the organization.

Present-day practice is to refer the design problem to a special development organization. This may be a part of the plant which is to be the user of the special machine, or it may be a nonaffiliated company. Mechanical ingenuity is the prime requirement within this group but it must be guided by a sound knowledge of proved construction. Machines of apparent complexity may be relatively free of trouble if the components are of good design. The designers need to be backed up by experts in individual fields.

The best place to correct mistakes in special-machine building is on the drawing board. When the layout has been completed and before details are made is the best time for a conference. All who are concerned with the construction, design, training, and use of the equipment should examine the layout critically. If this group is handled by a skilled leader, all of the basic

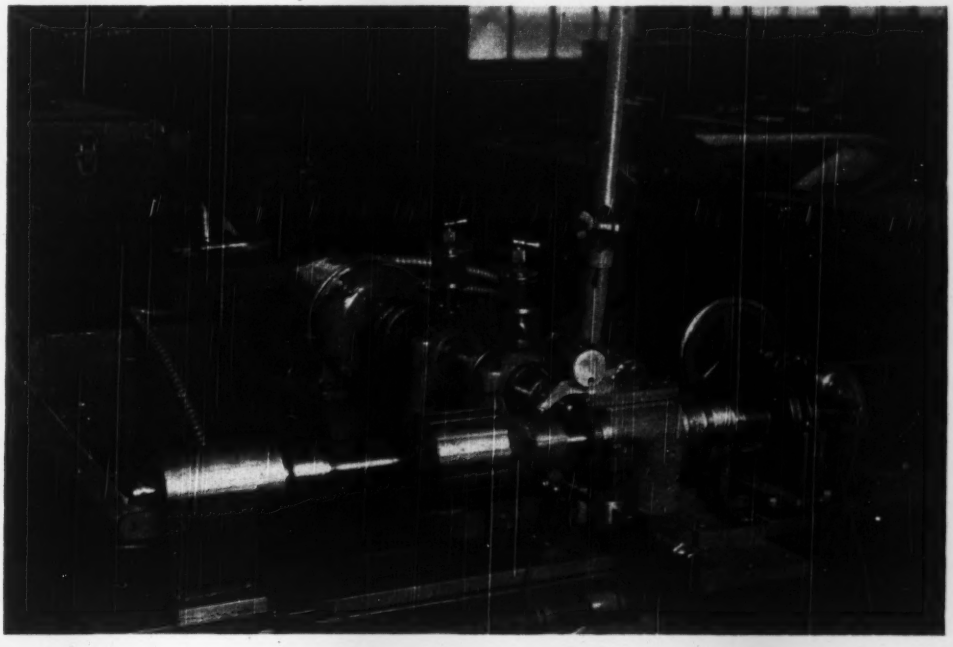


FIG. 1 MACHINE FOR SAWING UNDERCUT IN ARMATURE-COMMUTATOR MICA SEPARATORS

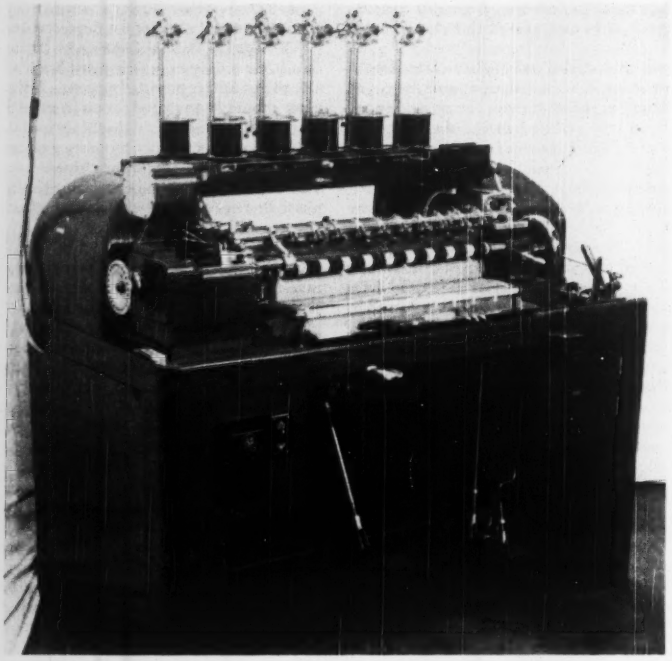


FIG. 2 MULTIPLE WINDING OF IGNITION COILS IS CARRIED OUT ON THIS MACHINE

faults of the design will be brought out. By including everyone in this meeting who will be involved in any phase of the project, and endeavoring to incorporate some suggestions from each one, there is assurance that everyone will be favorable to the project and eager for it to be a success. The general feeling must be that the equipment is being built for members of the production supervisory staff and not being forced on them. Selling down the line is as important as selling to management.

DESIGN PROCEDURE

A procedure for the steps in design and some of the factors to be considered during this process are given in the following:

1 Analyze the motions and their sequence. To do the work on the product that has been planned, the designer will find that certain movements of machine components are necessary, and that they must occur in certain time relation to each other.

2 Decide the type of machine which will best accommodate the movements and sequence. This may be a single-station, dial, in-line, drum-type, etc., and may be horizontal or vertical.

3 Analyze the forces required to be transmitted by the movements as well as feeds and speeds.

4 Study the most suitable means for supplying these forces. This is a controversial matter since it involves a choice between mechanical, hydraulic, air, and electrical. If the designer and the supporting engineering group have had sufficient experience with all four, the choice can be made intelligently. There will be occasions where one of the four methods is definitely indicated, and others where personal preference can rule.

5 The layout of the machine should be made and dissected thoroughly by the committee, which includes everyone who will have any responsible connection with the use of the equipment. Aside from the discussion of the four preceding factors, the following items should be discussed:

(*a*) What parts will be subjected to wear? These should be designed so that they have adjustments, are readily replaceable and are inexpensive. This may require that inserts be used on parts that would be costly to replace as a whole.

(*b*) Too often the lubrication requirements are ignored until a special machine has been completely assembled. At that time it is found difficult to carry oil to the points where it is necessary. Hardened parts may have to be annealed to provide oil passages. The lubrication should be effective without excess oil which could make the machine unsightly and damage the work being processed.

(*c*) The controls should be easily manipulated and convenient to the operator. An automatic cycling machine should be made so that it will either run fully automatic or will make just a single cycle. High-speed machines should have inching buttons.

(*d*) Both the safety of the operator and of the machine are to be considered. Adequate guards and feeding devices will protect the operator. Built-in safeties to protect the machine against overloading and improper sequencing will prevent many costly breakdowns. Some of these devices may be planned at this stage, but others will be added when the machine is being bugged. Many of these are added as a result of a machine failure.

(*e*) The operator's position at the machine, his duties, and the controls which he must operate will affect his satisfaction

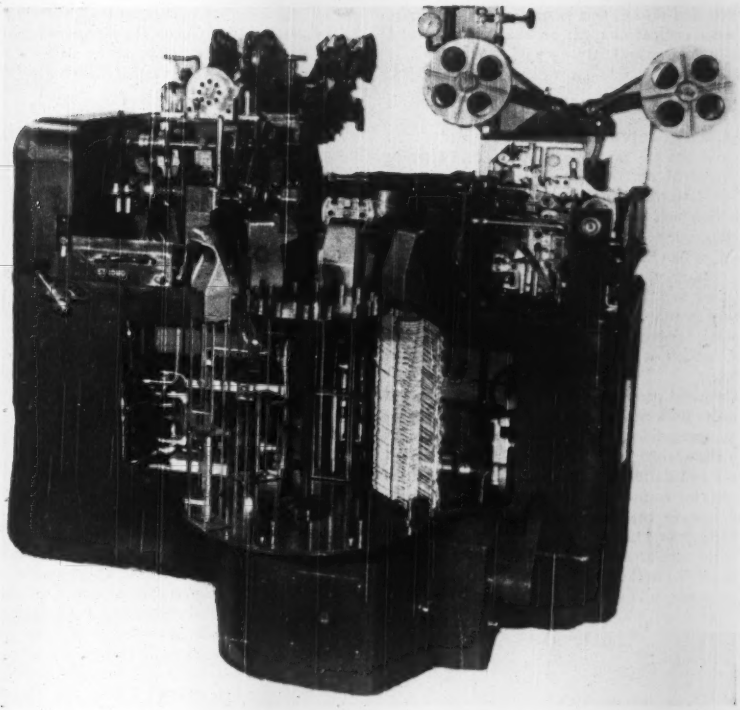


FIG. 3 AUTOMATIC MACHINE FOR WINDING GENERATOR-ARMATURE COILS

with the machine. The more nearly the machine fits the variations in physique of the operators who must use it, the less the foreman's troubles. Nothing can please an operator more than a comfortable foot pedal on a machine. Minimize his duties but not beyond the point where he will have sufficient regular work to perform to require him to stay at the machine.

(*f*) It costs little more initially to make the machine attractive, and the cost will be regained through lower maintenance. Heavy guards with smooth contours can dress up a machine and protect the working parts. Flimsy guards will soon be out of shape, ill-fitting, and will damage, rather than improve the appearance of the equipment. The use of decorative chrome on controls and important parts will deter the operator from damaging them.

The use of thin chrome decorative strips on the machine solely to make it "pretty" have no more value than the old-time practice of painting on flowers and butterflies. Carry the paneling to the floor, since it is easier to keep the floor clean than where there are four or more separate legs to sweep around. Supply places to keep the necessary tools.

(*g*) Avoid trick mechanisms. A design to be good need not be novel. It is better if there is nothing really new incorporated in the machine. If all of the mechanisms have been in successful use in the plant on other equipment, they will have been bugged out, and tool and maintenance personnel will be familiar with them. Simple proved mechanisms can be combined to produce very good special machines.

(*h*) Occasionally the machine will have to be moved from one place to another. The designer should provide eyebolts and prying lugs so that the machine will not be damaged in handling.

BUILDING THE MACHINE

When the design layouts have been approved, the individual parts are then detailed. All the parts should be as simple as possible for ease of manufacture and replacement. Standard parts should be used wherever possible.

The shop and designer should work closely together at all times to be sure that the drawings are like the machines. There may be only one built and it must work. The designer can often change his drawings to agree with shop errors to prevent costly parts being remade. Where a close relationship exists between designer and builder, many ways will develop to keep down the cost of the machine and improve its performance.

Building a special machine is a matter of making and assembling parts so that the finished product will accomplish the desired result. This is the costly part of the project, and careful supervision and records are necessary to keep the cost within control. Since the number of identical machines is small, considerable cost saving may be made by the designer and shop supervision working closely together. Frequently it is possible to make alterations to simplify construction or to permit use of parts not to dimension. Care must be taken to change drawings as construction changes are made, or future replacement of parts might cause excessive maintenance cost.

Making the machine work requires the highest order of ingenuity and patience. Fully 20 per cent of the cost of the

machine will be expended during this period. One danger is the tendency to make radical changes in the machine, and another is an unwillingness to make changes which are actually necessary. Experience and sound judgment are the only guides.

THE MACHINE GOES INTO PRODUCTION

When the machine begins to perform with reasonable success, it is time to place it in the hands of the operators and attempt production runs. Control of the machine should be taken from the builder and assigned to the operator trainer. The viewpoint of these two individuals is entirely different. The mechanic is in the business of building machines, and it is hard for him to consider a machine completed on which he has worked, perhaps for months. The operator trainer is only interested in the machine as a means of producing so many parts per hour. He wants to run it as long as it will produce, and resents any shutdown. Some of the failures of the machine to achieve perfection, which would annoy the builder, are of minor concern to him.

His job is to understand people and their movements as well as the machine builder understands the machine and its movements. Production supervision and time-study investigators work closely with the trainer, so that the job may be moved out into production and deliver at an agreed rate when it is ready. A good operator trainer can get a completed machine into a production line in the shortest possible time. In a special-machine-building organization he is invaluable.

Within a reasonable time after the machine is in production, its performance record is checked to determine if the original estimates have been made. This should be as complete in detail as the original cost estimate to which it is compared. Any variations from expected performance should be studied by the design and estimating group, and the knowledge added to the fund which has previously been built up.

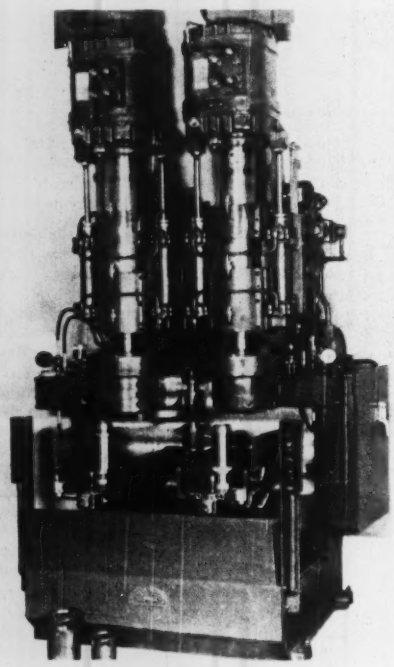


FIG. 4 TWO-SPINDLE SEMIAUTOMATIC MACHINE FOR BORING GENERATOR FRAMES

EXAMPLES OF SPECIAL MACHINES

Fig. 1 shows a machine for automatically sawing the undercut in the mica separators of armature commutators. This was formerly a skilled hand operation. The machine locates the mica electrically, automatically saws the slot, and indexes to find the next mica. One operator cares for a battery of the machines, since the hand work consists only of loading and unloading. The experimental machine shown was fed hydraulically, but it was found that mechanical feed in this case was simpler and less troublesome. With the present group knowledge, hydraulic operation of this machine would not ever have been considered.

The fundamental principle of this machine was the electric circuits involved. Without the co-operation between capable electrical engineers and machine designers, such a machine could not be developed. The efficiency of the machine was greatly increased through the added co-operation of the tool engineers who developed an inserted-tooth tungsten-carbide cutter which could be produced at low cost.

The ultimate success was thus due to combining the knowledge of experts in three different fields.

The machine shown in Fig. 2 is for multiple winding of ignition coils. The number of possible interruptions due to wire breaks, the necessity of the operator returning to the machine periodically to replace spools of wire, the length of hand time to load and unload the machine, made the determination of the most efficient number of these machines per operator a difficult problem. This was solved in a satisfactory manner by the operator trainer and the time-study engineer. This was the first special machine in the plant which was "dolled up" and although built 12 years ago, the machines have been a source of pride to operators and management and are kept in excellent condition.

Fig. 3 is a machine for winding generator-armature coils automatically. The guards have been removed to show the "apparent" complexity of the machine. Although the output is high, only the winding spindle and the index table operate at high speeds. The majority of the parts move at low speeds and are subjected to light loads. The device in the upper left-hand corner which resembles a dial telephone plate is a series of red-glass lenses, behind each of which is a signal light. When trouble occurs, the operator knows at once what part of the machine needs attention.

This machine was made possible by the product engineer who permitted the use of a heat-sensitive tape in place of a moistened gummed paper for binding the wires together. Rigid adherence to previous design would have prevented this improvement in productive methods.

The two-spindle semiautomatic special machine shown in Fig. 4 is for the purpose of boring the generator frames shown in front of the machine base. These are $4^1/_2$ in. ID. The material is hot-rolled low-carbon steel. About 0.030 in. of stock is removed at an over-all cycle of 20 sec per spindle. The chips and frames are dropped to a conveyer through the base of the machine. The machine is full-hydraulic in operation.

Although these parts weigh about 10 lb each, the fatigue factor has been reduced by supplying air-operated devices to elevate the parts into the chucks, and the frames fall to the conveyer below.

This machine, although entirely special was designed and built by a nonaffiliated organization.

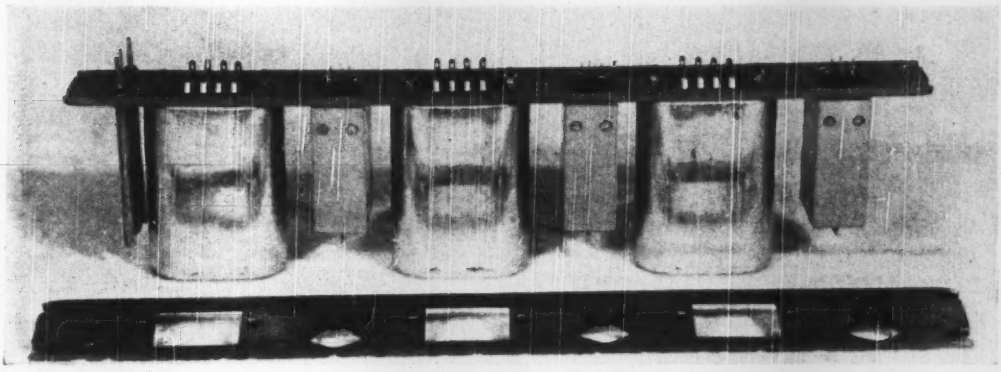


FIG. 1 FLAT NARROW-TYPE MOUNTING PLATE ARRANGED FOR MOUNTING A SINGLE ROW OF APPARATUS

PANELS *for* APPARATUS *Used in* COMMUNICATIONS EQUIPMENT

Manufacturing Panels Arranged for Mounting Apparatus

By A. S. MUESSEN

WESTERN ELECTRIC COMPANY, KEARNY, N. J.

MUCH of the equipment used throughout the various telephone central offices and installations is shipped from the factory in completely assembled and wired framework sections which require a minimum of effort to install in the field. A typical section consists of two steel uprights approximately 11½ ft high, suitably spaced and fastened by cross-members at the top and bottom. The apparatus required to make up the particular equipment is mounted on metal panels which in turn are fastened between the uprights.

The panels to which the various pieces of apparatus are attached are known as mounting plates. They provide rigid support for the apparatus mounted on the frame in positions readily accessible for initial apparatus adjustment and wiring and subsequent field maintenance. They also permit a division of the shop assembly operations in that all apparatus on a single mounting plate or group of mounting plates may be assembled and wired as a unit on a bench and later mounted on the framework section. This simplifies initial field installation and subsequent replacements or additions. In a product such as telephone equipment which is designed for a variety of special applications, these plates are needed in an almost infinite variety of punching combinations, although they may be confined to a small number of basic types. It is this variety of punching combinations which provides a problem in manufacture. This paper will describe the methods which have been developed for manufacturing these small lots of differing plates economically by reducing setup and machining time.

Contributed by the Production Engineering Division and presented at the Annual Meeting, New York, N. Y., November 27–December 2, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

TYPES OF MOUNTING PLATES

There are four types of mounting plates in general use, as follows:

1 The flat narrow type arranged for mounting a single row of apparatus. This plate is dimensioned to mount on the uprights at 1¾-in. spacing and is illustrated in Fig. 1. It is made from steel bar stock usually 7/32 in. thick × 1 23/32 in. wide.

2 The channel-type plates are also arranged for mounting a single row of apparatus. These plates are made of thinner metal sheet, usually about 0.090 in., and have formed flanges to add stiffness. They are made to mount on both 1¾-in. and 2-in. spacing. Fig. 2 illustrates these channel plates.

3 Flat panels are similar to the flat narrow plates, Group 1, except that they are made to various widths, and mount two or more rows of apparatus. In addition to steel sheet 7/32 in. thick, aluminum sheet is being used to a considerable extent for these panels. Fig. 3 illustrates this basic type.

4 Flanged panels are made of thinner sheet, usually 0.090-in-thick steel or aluminum and have two side flanges for stiffening. They are made to various widths. Fig. 4 illustrates this type.

PROBLEMS OF MANUFACTURE

Each group of plates presents its own problems. Generally, the apparatus is used interchangeably on all types of plates, and the same openings must be provided in all of the different types. Certain openings have been modified and standardized, where possible, to permit the most economical method of

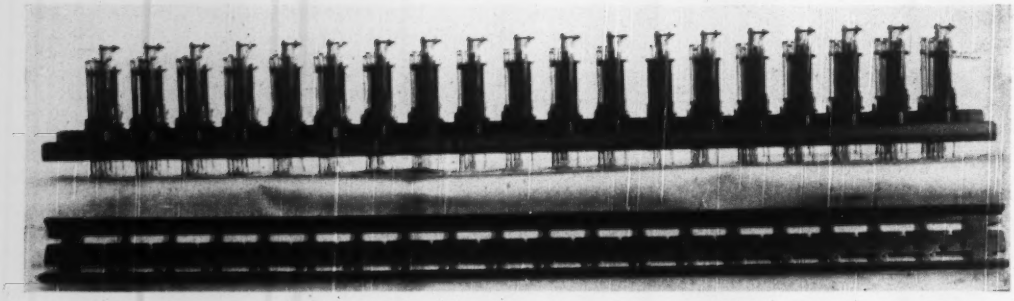


FIG. 2 CHANNEL-TYPE MOUNTING PLATE ARRANGED FOR MOUNTING A SINGLE ROW OF APPARATUS

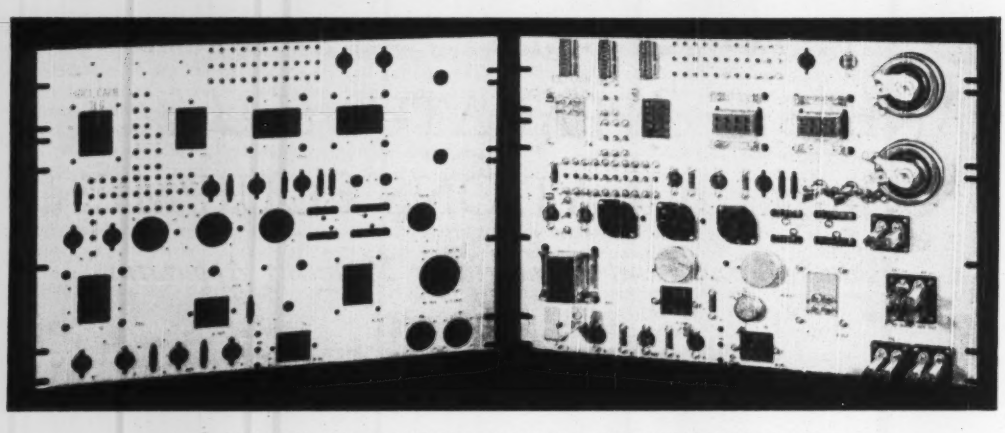


FIG 3 FLAT PANEL HAVING A NUMBER OF ROWS OF APPARATUS MOUNTED ON BOTH SIDES

manufacture. The use of a punch and die for perforating an opening complete in one stroke of the press is preferred over any other method, and every effort is made to design openings of such size and shape as will lend themselves to this method. In order to keep the number of tools required to a minimum, efforts are also made to design the openings to accommodate as many different pieces of apparatus as possible. Figs. 1, 2, 3, and 4 illustrate some of the more generally used openings and the apparatus mounted at these openings.

In order to simplify the assembly and wiring operations, the apparatus is usually mounted on one side of the plate, and the wiring connections are made on the other. The apparatus terminals extend through the openings in the plate to the wiring side. The complete apparatus opening serves two purposes, namely, to permit the terminals to project through the plate, and also to provide a means of fastening the apparatus to the plate with screws.

Flat narrow plates are ordinarily made to order to suit the particular application for which they are intended. Code numbers have been assigned to these plates; the code, however, signifies only a plate of a certain thickness, width, and length with definite centers for mounting apparatus. Thus the 600-A mounting plate is $^{7}/_{32}$ in. thick, $1^{23}/_{32}$ in. wide, 19 in. long, having apparatus centers spaced $1^{3}/_{4}$ in. apart. One 600-A plate may be quite different from another, depending upon the apparatus for which it is punched. A 600-N mounting plate differs from the 600-A only in that the mounting centers are spaced $2^{1}/_{4}$ in. apart. Spacings are not always equal on the same plate. Over a period of time many different codes have been standardized to meet various conditions.

These plates are made of bar stock clipped to length and notched at the ends in one operation. The notches, or slots, are for screws by which the plates are eventually fastened to the framework section uprights.

PUNCHING OPERATIONS

A press brake set up with a series of punches and dies for the more generally used apparatus openings is used to punch these plates. Approximately 80 per cent of all the openings are punched by this method. Fig. 5 shows a brake set up with 20 punches and dies for different apparatus openings, any one or combination of which may be selected for any one plate as required by the particular order.

Fig. 6 shows the frame used to position the mounting plate in the punches and dies. The frame carries a removable strip template with holes spaced as required for a particular mounting-plate code. A template is provided for each different code. The holes in the template are spaced and numbered to correspond with the position number on the plate. Any position number on the plate may be punched by indexing a pin attached to a sliding stop on the frame in the correspondingly numbered hole in the template and holding the end of the

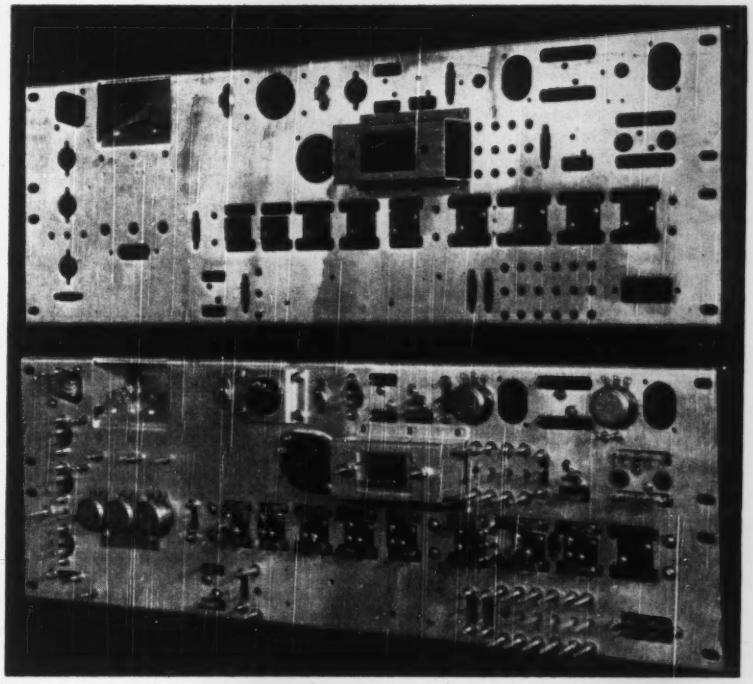


FIG. 4 FLANGED PANEL HAVING A NUMBER OF ROWS OF APPARATUS MOUNTED ON BOTH SIDES

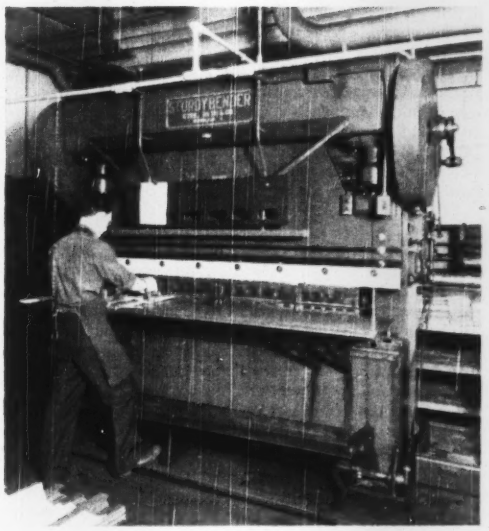


FIG. 5 PRESS BRAKE WITH 20 INDIVIDUAL PUNCHES AND DIES FOR PERFORATING FLAT NARROW-TYPE MOUNTING PLATES

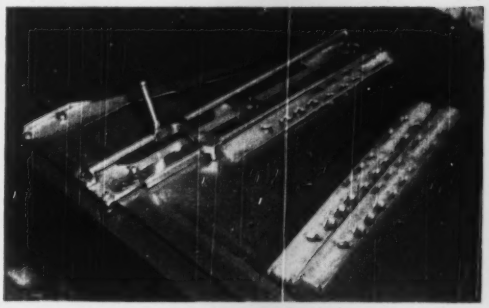


FIG. 6 FRAME USED TO CORRECTLY POSITION FLAT MOUNTING PLATES IN PUNCHES AND DIES ON PRESS BRAKE

mounting plate against the stop. Slightly rotating the stop counterclockwise disengages the indexing pin, allowing the stop to be moved horizontally on its supporting bar to the next position desired, where the index pin is again engaged by a clockwise motion.

A typical order will specify one 600-A mounting plate punched for an "E" relay in each of positions 1, 2, and 3, an "18" type resistance in each of positions 4, 5, and 6, and a "141" type condenser in each of positions 7, 8, 9, and 10. The operator selects the template for the 600-A plate and places it in the

frame. He places a mounting-plate blank in the die for the E relay opening, indexes to positions Nos. 1, 2, and 3 on the template, and punches three openings in succession. The plate is then shifted to the die for the 18 type resistance, and these openings are punched by indexing to positions Nos. 4, 5, and 6. This step is repeated on a third die for the 141 type condenser opening where positions 7, 8, 9, and 10 are punched. In this way, the plate is completely punched in one handling at the machine.

Plates punched in this manner are subjected to considerable distortion and have a distinct bow. For this reason a roll straightening machine is used to straighten the plates.

Insulating bushings of hard rubber are inserted in certain holes when it is necessary to insulate the apparatus from the plate. These bushings are inserted on a bench by a hand operation. The insulating bushings are made of hard-rubber tubing cut to the desired length by means of a knife-edge blade mounted in a commercial nibbling machine which has been adapted for this purpose. Electrical heating units are employed to soften the rubber to prevent it from shattering.

CHANNEL-TYPE PLATES

Channel-type plates are made by means of an entirely separate group of machines and separate tooling. The blanks

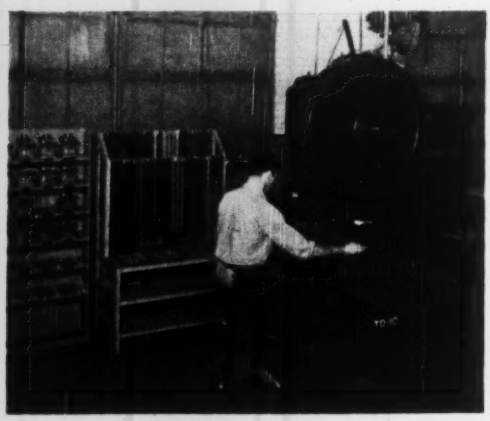


FIG. 7 PUNCH PRESS SET UP FOR PERFORATING APPARATUS OPENINGS IN CHANNEL-TYPE MOUNTING PLATES

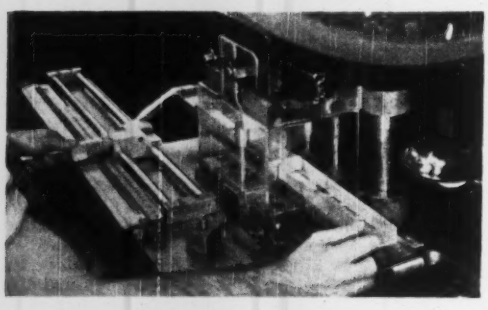


FIG. 8 CHANNEL-TYPE MOUNTING PLATE IN POSITION TO BE PUNCHED

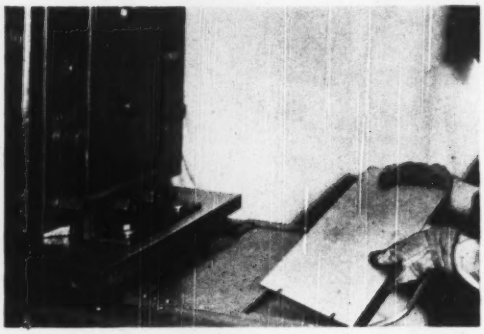


FIG. 9 TOOL USED FOR PRESSURE SPOTTING HOLE CENTERS IN A MOUNTING PANEL

are clipped to length and notched from steel strips. The plates are formed into a channel shape after which they are stamped and punched to order to mount apparatus as required by specific applications. The same system of coding is used as was described for flat narrow plates.

The method of punching the apparatus openings is somewhat different, however, in that a punch press, equipped with a holder for quick-change punch-and-die units, is employed instead of a press brake with a permanent setup of a series of punches and dies. This is done because the number of tools required on channel plates is considerably greater than on flat plates, and several press brakes would be required to provide for all the tools if they were all set up together. The punch press set up for perforating is shown in Figs. 7 and 8.

A series of template bars is provided for the coded plates when the spacing between position centers is $\frac{1}{2}$ in. or over. Certain codes, however, have centers spaced at $\frac{1}{8}$ in. Since this is too close for $\frac{1}{4}$-in-diam index holes, a rack with teeth of $\frac{1}{8}$-in. pitch is used, each tooth numbered to correspond with the position number on the plate. In using this tool, the unit for punching the required opening is placed in the holder. By indexing to the proper hole in the spacing bar or the tooth on the rack, the stop is set to punch a position center. All of the same openings are punched at one handling. The punch-and-die unit is then removed, and a new one inserted to punch other openings. This is repeated until all the openings specified on the order have been punched. Changing the punch-and-die units in the holder is a matter of seconds.

FLAT-PLATE PANELS

Panels or wide flat plates are obviously more complicated and, because of this, more involved methods are required. In addition to the usual apparatus positions used on the narrow plates and channel plates, panels have many ordinary tap and drill holes. The apparatus in many cases is mounted on both the front and rear of the panels and may be mounted in several different positions, all of which serves further to complicate the job of tooling. Essentially, this is a small-lot job, most panels being ordered in lots averaging about 15. To meet this condition, a system has been developed whereby all holes, whether drilled or punched, are located from spot marks or center-punch marks transferred to the panel blank from an accurate template in an initial operation. For lots up to 10 pieces, the template is simply clamped to each blank, and the centers spotted on a drill press, one hole at a time. On larger lots, a punch press is used for center-punching all holes at one stroke.

Center punches all of the same height are placed in the holes of the template. The template is placed in a sliding holder on the machine with the center-punch points up. The workpiece is nested over the template. The holder is pushed under the ram of the press so that when the press is tripped and the ram descends, each center-punch point leaves its impression on the workpiece or blank. This arrangement is shown in Fig. 9.

The template accompanies the panels to each succeeding machine operation. Suitable markings on the template indicate the sizes and shapes of the various drilled, tapped, and punched holes required. All the information necessary to complete the plate is shown on the template so that reference to blueprints or layouts by the operators is unnecessary. Ordinarily the template is their only information source. In addition, it is used by the operators for checking their work. By placing the panel over the template the location and size of the holes in the panel may be compared visually to the markings on the template.

TURRET-PRESS OPERATIONS

The small holes are drilled to size from the center-punch marks. The larger holes and holes of odd shape are punched on a battery of 4 turret presses on which 64 tools are always available. Pilots in the punches or dies in these tools locating from previously drilled holes are used for positioning; no gage stops are used on these machines. While this method requires a few extra drill holes, it is more economical in the long run on small lots because it eliminates the time which otherwise would be required for setting stops and extra handling. Fig. 10 shows a 20-station turret press.

Panels or wide plates made of material up to $^1/_8$ in. thick with flanges can usually be punched completely and do not require a drilling operation. An 18-station turret press equipped with a work-positioning device working directly from a template fastened to the machine is used for these plates. Fig. 11 shows this machine.

A work carrier having longitudinal and transverse movement on ball bearings is positioned by inserting a plunger on the carrier into the desired hole in the template. This automatically brings the workpiece into the same relative position under the punch. As the plunger enters the hole in the template it actuates a microswitch which operates a solenoid to trip the press. This feature serves to speed up the operation since there is no time lag for tripping the press once the plate is positioned, which would be the case if a separate foot treadle were used. Since the microswitch is adjusted to operate only after the plunger has descended sufficiently to engage a hole in the template, the arrangement also serves to prevent accidently punching out of position.

Each hole on the template is identified by a certain color, all holes of the same size and shape being colored alike. A tab of corresponding color is attached to the machine turret at the punches for these holes. The operator indexes the turret to the punch with a red tab. He then proceeds to punch all of these holes at every hole in the template colored red. He then indexes the turret to the next color—say, green—and punches all the holes colored green on the template. This is repeated until all the different holes have been punched.

This machine eliminates spotting or center-punching and all drilling. It is accurate; holes can be punched well within the 0.016-in. limits for location required for this class of work. It is fast. All holes can be punched in one handling on the machine. Certain clusters or patterns of two or more holes can be punched complete in one stroke by providing suitable punches and dies when repetition warrants, thereby making further savings possible. The setting of stops or gages has been eliminated entirely, and the accuracy of the product is controlled within the accuracy limits noted previously by the template so that a skilled operator is not required.

FIG. 10 TWENTY-STATION WIEDEMANN TURRET PRESS USED FOR PUNCHING MOUNTING PANELS

FIG. 11 EIGHTEEN-STATION WIEDEMANN TURRET PRESS EQUIPPED WITH WORK-POSITIONING DEVICE LOCATING FROM A TEMPLATE

CONCLUSION

In a shop which normally employs about 100 operating people these facilities and methods have reduced skilled layout and machine setup effort by a good many thousands of hours a year. The replacement of hand bench work with machine- and tool-controlled operations has also resulted in substantial improvement in over-all product quality.

Many of the methods described have been extended to products other than mounting plates, including steel framework and sheet-metal-casing production. The over-all results obtained offer tangible evidence that engineering can make important contributions in overcoming the problems of jobbing production.

The ENGINEER *as a* MANAGER

By J. M. JURAN

CHAIRMAN, DEPARTMENT OF ADMINISTRATIVE ENGINEERING, NEW YORK UNIVERSITY. MEMBER ASME

MORE than half of the young engineers of today aspire to end up as executives or managers. Less than half of the young engineers aspire to end up as scientists, consultants, teachers, or other nonmanagers.

The young engineers who would be managers aspire not merely to become the managers of engineering departments. They hope to become general managers, officers, and directors of companies, in capacities which oversee not only the activities of engineers, but of others as well.

In these aspirations, the young engineers are not alone. The young accountants, lawyers, salesmen, mechanics, and many others likewise hope to become managers.

This keen and extensive competition to occupy managerial posts is a sign of increasing alertness to the vital role of the manager in the industrial society. In past centuries, leadership in the economy has been held variously by the soldier, the merchant, the priest, the philosopher, the financier. Today, and for the forseeable future, the manager dominates the economy.

It is the purpose of this paper to analyze the qualifications of the engineer for managerial posts. To make this analysis it is necessary to consider the following:

(*a*) What is the relationship of management to engineering?

(*b*) Does engineering training qualify one to become a manager?

(*c*) What must the engineer do to become a manager?

RELATIONSHIP OF MANAGEMENT TO ENGINEERING

The skills needed to perform the tasks of modern industrial society are exceedingly varied. They include the numerous mechanical skills exercised in the factory, office, warehouse, on the farm, on the railroad. They include the professions. They include, of course, the skills of the scientist and of the engineer.

But the skill of the manager[1] is different from any of these. Essentially, the role of the manager is to get things done through other people. To carry out this role, the manager requires skills which are as yet not well understood, and certainly not well executed. The knowledge of "how to manage" is only now being developed. The art of management today stands perhaps in the situation that understanding of electricity stood in the days of Volta, Galvani, and Ampere.

The distinguishing feature of engineering is the use of "the forces of nature" for the benefit of man. The distinguishing feature of management is the use of "the forces in people," also for the benefit of man.

The forces of nature are discovered and measured by the "natural" scientists—the mathematician, the physicist, the chemist. The engineer utilizes, for the benefit of man, the knowledge discovered by these and other natural scientists.

The manager, in contrast, uses the forces of human beings, also for the benefit of man. The forces of human beings are discovered and measured by the "living" scientists, the biologist, the psychologist, the sociologist, and others.

To utilize the forces of nature, the engineer has evolved various bodies of engineering knowledge: thermodynamics, machine design, electrochemistry, and many others. These bodies of knowledge are engineering tools. Success in engineering depends in good measure on the extent to which the engineer can grasp and use these engineering tools.

Similarly, to utilize the forces of human beings, the manager has evolved various bodies of managerial knowledge: organization, controls, incentives, and many others. These bodies of knowledge are management tools. Success in management depends in good measure on the extent to which the manager can grasp and use these management tools.

However, there is a further consideration, one of the utmost importance. We cannot utilize the forces of nature, except through the medium of human beings. A machine designed in accordance with engineering principles must still be constructed, operated, and maintained by human beings. (The engineer who designs it is himself a human being.) This is the thinking behind the 1913 ASME definition of management:

"Management is the art and science of preparing, organizing, and directing human effort applied to control the forces and to utilize the materials of nature for the benefit of man."[2]

The foregoing explains, in the author's opinion, why the manager so universally "outranks" the professional man in popular contemplation. The manager outranks the engineer. The dean outranks the professor. The director of research outranks the scientist. The general outranks the ballistics expert. The bishop outranks the priest. And so on and on. The manager outranks the professional man because it is so universally recognized that utilization of the forces of nature can be done only through human effort.

CASE HISTORY OF AN ENGINEER WHO BECAME A MANAGER

In making these distinctions between engineering and management, I hasten to add that relatively few jobs involve "pure" engineering or "pure" management. We can trace the career of a young engineer to see how imperceptibly he glides from engineering into management.

In 1922 Bill was a young mechanical engineer fresh out of engineering school. Bill was ambitious, but not to a point of fanaticism. He decided he was going to join a good company as a second lieutenant, climb the ladder, rung by rung, and retire on a colonel's pension some 40 years later.

So Bill joined the X company, one of the industrial giants. Bill was on a training course for almost a year, going around from department to department, learning about the business. Then he was given a job as assistant engineer in one of the product-design departments. He was on the drafting board for a few months, then prepared bills of material for a few months, then had a job of doing odds and ends in the drafting room. In 1925 he was designated "engineer," and became one of a flying squadron of engineers who were assigned, first to this project engineer, then to that project engineer, figuring stresses, designing components, choosing materials, and performing

[1] The term "manager" is used here in its generic sense as one who must act through the efforts of other people.

Presented at the Management Conference under the auspices of the Metropolitan Section and the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, N. Y., Oct. 13, 1949.

[2] Transactions ASME, 1913, p. 1272.

other engineering chores. Bill did these things until his promotion to project engineer in 1928.

Until that promotion, Bill was almost all the time using the forces of nature for the benefit of man. Most of the time Bill was using Young's modulus, Ohm's law, other laws, some calculus, lots of arithmetic. The visible evidences of Bill's work were in sketches, calculations, memoranda. Bill's engineering training was very helpful in doing all of these things.

But Bill was also dealing with people. He had various bosses in the form of project engineers. He worked with associates under the same boss. He worked with shop supervisors, with draftsmen, with production expediters, with accountants, and with still others. Bill's engineering training was devoid of any suggestions on how to work with a boss or with these other people.

During the latter part of this time Bill had an assistant—a young fellow just out of college, who was assigned to Bill for training. Bill was able to get this trainee to take data, make calculations, prepare drawings. Here Bill was achieving things not just through his personal efforts—he was utilizing the force of a human being. He was, on a small scale, managing.

As project engineer, Bill's duties changed. He now spent much less time in calculations or in sketching—the engineers who "reported" to him did those things. He assigned work to them, reviewing the work as it progressed. He now had to make broader decisions, but still largely of an engineering character, still of a character which utilized the forces of nature.

But as a supervisor, Bill now had also a set of duties concerned with human beings. Each person was different. Ed, the old-timer, was willing to work but was in bad health. Frank was about Bill's age, and was burned up because he thought that he rather than Bill should have been made project engineer. Steve was another tough case—he was openly fed up. The company hadn't treated him square. And so on and on. How to get these men to work wasn't in the engineering books. How to get these men to work together wasn't in the books either.

The relative ease of commanding "things" was in sharp contrast to the difficulty of commanding people. "Things" could be pushed around by force. People couldn't be pushed around like that. People had to be persuaded.

We skip over the headaches of the depression of the early thirties and the recovery. We credit Bill with much foresight for his decision to go back to school and to take night courses in management. In these courses he discovered that these new management problems of his were very old, that they had names, that they had been analyzed, and that there existed ways of solving them.

It is 1937 and Bill is chief project engineer for the whole division. Bill still makes decisions of an engineering character, but now strongly flavored with other considerations. Most of his time is now not on engineering problems at all. He spends much time in meetings with other department heads. Their discussions and decisions involve many varied problems—accounting, patent law, collective bargaining, sales forecasts, advertising, government regulations. Most of these discussions seem quite remote from engineering. Now when Bill wants to get something done, he assigns it to a project engineer, or he asks some other department head to get it done for him.

In 1945 Bill became engineering manager for his division. Now he was top dog among the engineers, but he did very little engineering. His calculus had long since rusted into disuse. He remembered few formulas. His time was spent in looking over budgets, attending conferences, approving memoranda and reports, rating subordinates, performing numerous personnel duties.

Bill isn't through progressing. The general manager of the division is due to retire, and Bill will become general manager of the division. Then he will become responsible not only for engineering, but for manufacture, and sales as well. All pretense at utilizing the forces of nature will be abandoned. Especially when it comes to sales and manufacture, Bill will have to rely absolutely on the experts—on the men down the line who are supervisors, accountants, market analysts.

Before Bill retires he will have become a vice-president of the company, and a director. In these posts he will be in the cabinet. He will contribute to discussion and decision affecting all phases of company operation—not merely those phases for which he is officially responsible. The transition from engineer to manager will be complete.

In following Bill through his success story, we see that while the cleavage between management and engineering is abrupt enough in theory, the transition in practice is most gradual.

DOES STUDY OF ENGINEERING QUALIFY ONE TO BECOME A MANAGER?

Our definition is that the manager is one who utilizes the forces in human beings for the benefit of man. Engineering provides no training on what are the forces in human beings, let alone how to use these forces. We must conclude that study of engineering does not qualify one to become a manager.

But neither does study of law, medicine, accounting, or any other one of the professions specially qualify one to become a manager. Does it follow that the young engineers, lawyers, or accountants who aspire to become managers all went to the wrong schools? What should they have studied?

The answer is that there is today no school which purports to turn out men capable of stepping into managerial posts. If there were such a school, it is most unlikely that the graduates would secure placement as managers. For while industry has no scientific method for identifying good managers, it does know that good managers must possess certain special qualities such as balance, maturity, and leadership, and that to acquire and season these qualities requires much time and experience as well as training.

Today there is not even an agreed-upon program of study for potential managers. For the most part the potential managers must learn from their elders, perpetuating their good or poor practices, just as did the lawyers and doctors of a century ago.

Does it mean that engineering is to continue doing business at the old stand, leaving engineers to gravitate into managerial posts as best they can? If the engineering profession concluded this, it would be a disservice to the aspirations of a majority of its members. The engineering profession should, rather, adopt a course of action which would aid engineers to qualify themselves more readily for managerial posts.

I do not advocate this on the familiar contention that the engineer, having built the machine, is thereby best qualified to oversee the Machine Age. In fact, I disagree with that contention. My argument is rather that the engineer, aside from his knowledge of the machines, is trained in a methodology sorely needed in management.

The engineer builds structures and machines through the engineering method of scientific utilization of natural laws previously discovered by the natural scientists. Built in this way, the structures stand and the machines run. Failure is so rare as to be newsworthy.

The need in management is to build organizations of human beings to run so well so often that failure likewise becomes so rare as to be newsworthy. An important prerequisite for meeting this need is scientific utilization of the forces of human beings as these forces are discovered by the "living" scientists. The engineering method is sorely needed in management,

though applied to knowledge of the living sciences rather than the natural sciences.

Returning to the question, "Does engineering training qualify one to become a manager?" we can now say that engineering training can be most helpful because it supplies an important methodology, that of the engineering method of decision based on knowledge derived from reproducible experiment. However, this methodology is not enough. True, the engineer is all dressed up with a methodology which is valuable to the solution of management problems. But the engineer as such has no place to go except in engineering, because his knowledge of the living sciences is not adequate for the managerial task.

I believe this is one explanation why many engineers, despite their admirable logic, remain technicians while the arts-school graduates, the lawyers, the salesmen seem to go on to become chief executives. (Incidentally, some engineers also end up in the high circles.) These rivals, though not so strictly schooled in the discipline of the engineering method, are generally better equipped with knowledge of the living sciences. Thereby many of them have a better grasp of the thing we call human nature.

WHAT MUST THE ENGINEER DO TO BECOME A MANAGER?

Again we return to the definition of management—the utilization of the forces of people for the benefit of man. Implied in this definition is the knowledge of:

(*a*) What are the forces of people?
(*b*) How are these forces utilized?
(*c*) What is for the benefit of man?

These questions are so fundamental in character that it may well be contended: "Surely the managers of today do not know these things and yet they get along. Is this knowledge then essential?"

It is true that only rarely does a manager of today know all these things. But it is stretching a good deal to say that the managers "get along." The mortality rate of business enterprises is shockingly high. We can build bridges, generators, aircraft, with the highest confidence that they will perform per specification. But we have no such confidence when we launch a new business enterprise, or when we set up a new department in an existing enterprise.

Today, the engineer who seeks to prepare himself for a managerial post is on his own volition turning to the graduate schools of Administrative Engineering and of Business Administration. There he studies psychology, sociology, and others of the living sciences to learn more of man as an individual and of men as a group. He studies various tools of management—organization, controls, incentives—to learn how to utilize these human forces; and he studies economics, law, and other disciplines to learn what is for the benefit of man.

All this is progress. Yet it seems to me that as the tempo of the industrial society steps up, the caliber of the manager must rise remarkably. In particular, the manager must see in proper perspective the relation of all the living sciences to each other. Only through such perspective can he perform the trusteeship job which is his duty if he is to emerge as a member of a profession.

SHOULD THE DEFINITION OF ENGINEERING BE OPENED UP TO INCLUDE MANAGEMENT?

It has been advocated by some that we should change the definition of engineering to read: "Engineering is the utilization of the forces of nature and of human beings for the benefit of man." This would not be the first time that engineering has increased its scope.

But can management, which rests on the living sciences, become a branch of engineering, which rests on the natural sciences? I doubt it. To stretch engineering to include the living sciences, it seems to me, goes beyond the elastic limit.

In my opinion, it is most desirable that the engineering profession be as well represented in top management as are the other professions and the arts. The industrial society is bound to run askew if policymaking and execution is dominated by the banker, or the lawyer, or the labor leader, or for that matter, by the engineer.

The risk today is not that management will become top-heavy with engineers. On the contrary, the risk is that engineering training, with its great emphasis on the natural sciences, will develop increasingly a "trained incapacity" on the part of engineers to advance into managerial posts. Years of commanding kilowatts and decibels, and of securing invariable compliance, can be sorry training for a managerial post where command means so little and where leadership means so much.

TRAINING ENGINEERS IN MANAGEMENT

The engineering colleges took a long stride toward broader development of engineers by adopting the so-called humanities courses. Until the adoption of the humanities courses, the undergraduate engineers were so closely confined to the study of things, that there was little time for study of people.

I doubt that much more can be done at the undergraduate level to prepare engineers to be managers. True, the undergraduate can learn something about industrial-engineering tools. But he has neither the experience nor the maturity to grasp firmly the nature of the managerial problem of doing things through other people. For the forseeable future, the opportunity for training engineers in management lies in graduate study and in industry itself.

Opportunity for such graduate study in the colleges is expanding rapidly, both in the variety of courses and in the number of colleges offering such courses. The interest on the part of graduate students is likewise expanding rapidly.

But in the immediate future the biggest role in training for management is to be played by industry itself. A serious limitation on college training in management is the lack of an adequate laboratory. In study of management, the laboratory is industry itself. To utilize this laboratory suggests that industry must participate heavily in the job of training. In time we will work out a decidedly better collaboration between industry and the colleges. Meanwhile, the fact that industry has so nearly a monopoly on the management laboratory puts a special duty on industry to identify prospective managers, and to help teach them how to manage.

For industry to teach men how to manage still requires close collaboration between industry and the colleges. Industry abounds in case histories, but discovery of principles from these cases requires a forum which can collect the experience of many companies.

In our graduate courses and in our management round tables at New York University we bring together men from a variety of industries to study various aspects of management. The college provides the forum but industry provides the cases.

However, we are far from having discovered all the possible devices for teaching management to men in industry. For example, there are current experiments in England wherein a man works in industry four days a week and spends the fifth day in graduate study at college. In some of the American companies, men of managerial promise are given special training through rotation, through participation in committee work, through schemes of "multiple management," through assignment to staff positions, and through still other means. The

(*Continued on page 320*)

PROGRESS *in* RAILWAY MECHANICAL ENGINEERING[1]

1948-1949

CONTINUING the trend in recent years, the installation of Diesel-electric locomotives has been the outstanding factor in the mechanical-engineering progress of the American railroads.

More new locomotives were installed in America during the first 8 months of 1949 than in any corresponding period in nearly 25 years. During these 8 months, Class I railroads installed 1249 new Diesel-electric locomotives, a 56 per cent increase over the corresponding 1948 installations. Forty-seven new steam locomotives were installed during this period, as compared to 41 during the corresponding 1948 period.

Indicative of the phenomenal growth in the services being performed by Diesel-electrics, in 1941, only 0.2 per cent of the total gross ton-miles of freight was handled by Diesel-electrics, by 1948 this percentage had increased to 21.3. During 1941, 7.8 per cent of the passenger-car-miles was handled by Diesel-electrics, and this had increased to 39.6 per cent in 1948.

Domestic railroads and refrigerator-car companies placed 66,564 new freight cars in service during the first half of 1949 as compared with 69,083 in the same period of 1948.

With over 11,000,000 Diesel-electric horsepower now in service, the American railroads are finding more extensive applications for units of the 1500-hp size for road haulage and 1000-hp for general switching use. The general decline in railroad traffic has, however, resulted in a marked decrease in the orders placed on manufacturers for new locomotives. Even more significant has been the sharp drop in orders for new freight and passenger cars.

Continued activity in the development of Diesel locomotives for foreign railroads will be noted elsewhere in this report.

Although foreign railroads are continuing to install steam and electric locomotives in appreciable quantities, these types of motive power, other than units covered by this report, have been, essentially, duplicates of orders reported by this Committee in previous years.

The apprehension over the domestic fuel-oil supply, which was being discussed widely last year, has slackened as the supply of petroleum products has caught up with demand and stocks have become relatively ample.

STEAM LOCOMOTIVES

An experimental steam locomotive, having six coupled axles and two high-pressure and four low-pressure cylinders, has been placed in service by the French National Railways. The locomotive, illustrated in Fig. 1, and described in Table 1, is designed to give a high and sustained tractive effort at moderate speeds. To attain improved thermodynamic efficiency, a supplementary superheater (a resuperheater) between the high-pressure exhaust and the low-pressure admission is used. This feature secures a high degree of superheat for the low-pressure cylinders without excessive superheating for the high-pressure cylinders. A steam jacket for the low-pressure cylinders is used to reduce condensation. The longitudinal section shown in Fig. 2 shows the location of the high-pressure and low-pressure systems.

ELECTRIC LOCOMOTIVES

An electric locomotive (Fig. 3, and Table 2, item 1) with a novel system for supporting the cab on the trucks without center plates, was constructed by Alsthom for experimental service on the French National Railways. Fig. 4 illustrates the disposition of the oscillating pivots supporting the cab structure on the truck, the restraint devices for centering the pivot assemblies, and the stabilizing devices located at the outer edges of the cab platform designed to hold the cab in an erect position with respect to the truck frame. The system is designed to give the same effect in riding as the conventional floating bolster commonly used in two-axle motorized trucks, and, at the same time, to permit the use of three motored axles with good access to the center motor for maintenance and inspection purposes. The system is also applicable—and has been applied—to two-axle trucks where but a single oscillating pivot is used. Fig. 5 is a "worm's-eye" view of the underside of the cab platform showing the oscillating pivots and their associated restraint devices ready for attachment to the truck frame.

The dual-purpose locomotive shown in Fig. 6 is one of a group built in the United States for service on the Chilean State Railways. In road service the locomotives are designed to operate with power being supplied to the four traction motors directly from the 3000-volt d-c overhead line. In relatively slow-speed switching service, the motors operate from 1500-volt d-c power which is supplied through a 3000/1500-volt dynamotor. Characteristics are given in Table 2, item 2.

DIESEL LOCOMOTIVES

A new line of passenger locomotives, the E-8, one unit of which is shown in Fig. 7, and described in Table 3, item 1, has been developed by General Motors' Electro-Motive Division. Equipped for multiple-unit operation, three such units compose a 6750-hp locomotive. Available with dynamic braking, this locomotive is designed for operating speeds up to 117 mph. Notable in the new E-8 design is the pressurized engine room which contributes materially to the cleanliness of the cab interior.

Another new design brought out by Electro-Motive is the F-7 line of 1500-hp units designed for use as either heavy-duty freight or passenger locomotives. Operated in multiple-unit arrangement, four such units make up a 6000-hp locomotive. The details of this unit, two of which are shown in Fig. 8, are given in Table 3, item 2. A slight modification of the unit, identified as the FP-7A model, is described in Table 3, item 3. Being 4 ft longer, the latter unit provides a total of 1750 gal of

[1] Report of Committee RR-6, Survey; chairman, T. F. Perkinson; members, E. R. Battley, Fred Benger, R. M. Coultas, R. P. Johnson, and F. L. Murphy.

Contributed by the Railroad Division and presented at the Annual Meeting, New York, N. Y., November 27–December 2, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

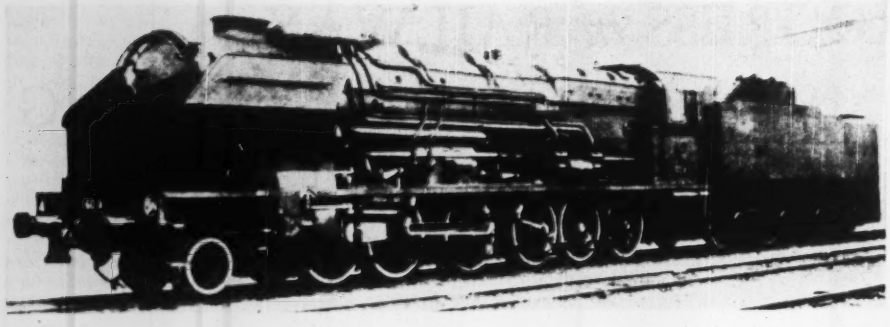


FIG. 1 SIX-CYLINDER FREIGHT LOCOMOTIVE

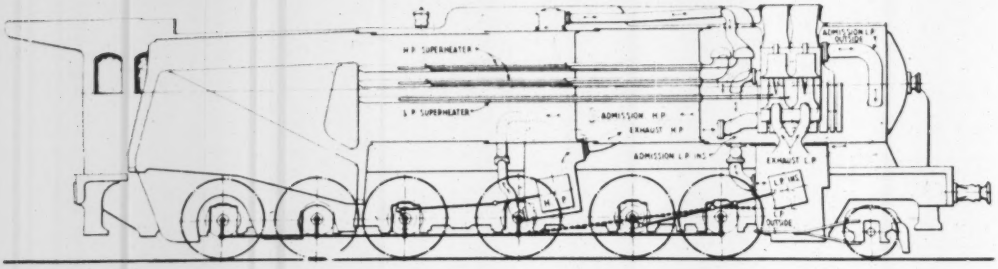


FIG. 2 SECTION SHOWING HIGH- AND LOW-PRESSURE SYSTEMS OF LOCOMOTIVE IN FIG. 1

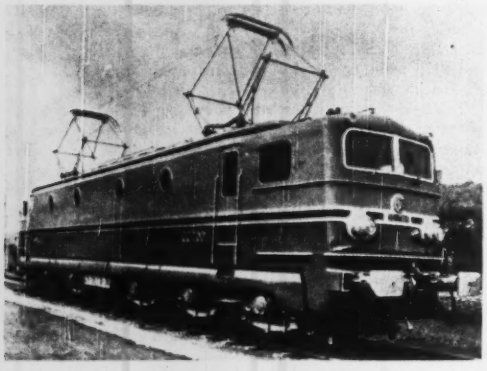


FIG. 3 HIGH-SPEED PASSENGER LOCOMOTIVE FOR FRENCH NATIONAL RAILWAYS

water capacity when dynamic braking is not employed, and 1150 gal when dynamic-braking facilities are furnished.

A Baldwin Locomotive Works four-unit 6000-hp freight locomotive, built for the Pennsylvania Railroad, is illustrated in Fig. 9, and described in Table 3, item 4. This locomotive, incorporating electrical equipment manufactured by Westinghouse, has a starting tractive effort of 260,000 lb based on 25 per cent adhesion.

Baldwin Locomotive Works has also introduced a six-axle, 1500-hp, road-switching locomotive having all weight on drivers. Illustrated in Fig. 10, this locomotive is specifically designed for hauling heavy tonnage at slow speeds. Details are given in Table 3, item 5.

TABLE 1 STEAM LOCOMOTIVES

Builder	French National Railways
Owner	French National Railways
Wheel arrangement	2-12-0
Service	Freight
Cylinders:	
Number	2 high-pressure; 4 low-pressure.
Diameter	20 1/2 in., high-pressure; 25 1/4 in., low-pressure
Stroke	21 1/4 in., high-pressure; 25 5/8 in., low-pressure
Boiler pressure, psi	265
Driver diameter, in.	55 1/8
Weight on drivers, lb	263000
Total weight, running order, lb	270000
Track gage, in.	56 1/2

Lima-Hamilton Corporation, a long-established steam-locomotive manufacturer, entered the Diesel-electric field during the year with the introduction of a 1000-hp switching locomotive. Illustrated in Fig. 11, this unit is described in Table 3, item 6.

The American Car and Foundry Company has built a new type lightweight high-speed passenger train, a prototype of two more which will be built for service in Spain. The initial train, known as the "ACF-Talgo," is powered by a locomotive of unusual design. The locomotive has four Diesel engines, two of which develop 810 hp for electrical drive, and the other two being used for 110-volt a-c auxiliary power. The auxiliary alternator sets supply the train with electric power for both heating and air conditioning, as well as lighting. The "train-line" water system supplied from the tanks in the locomotive is

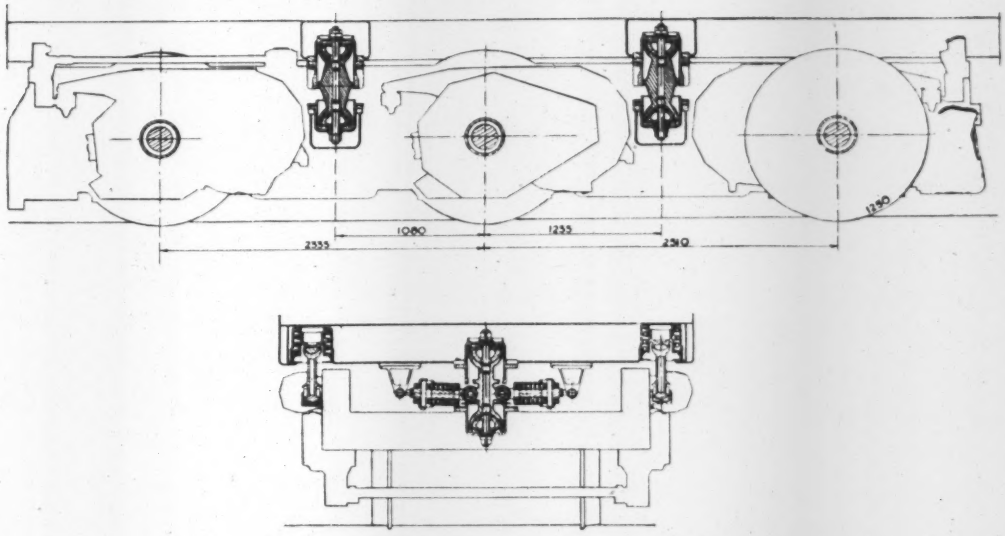


FIG. 4 SCHEMATIC DISPOSITION OF CAB-SUSPENSION ELEMENTS FOR LOCOMOTIVE IN FIG. 3

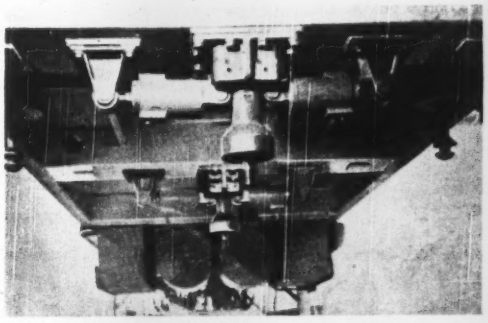


FIG. 5 UNDERSIDE OF CAB PLATFORM OF FRENCH LOCOMOTIVE SHOWING OSCILLATING PIVOTS AND RESTRAINT DEVICES

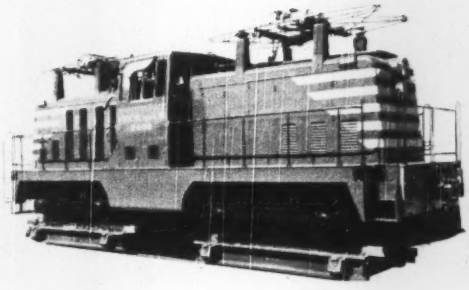


FIG. 6 "DUAL-PURPOSE" 1500-VOLT D-C LOCOMOTIVE

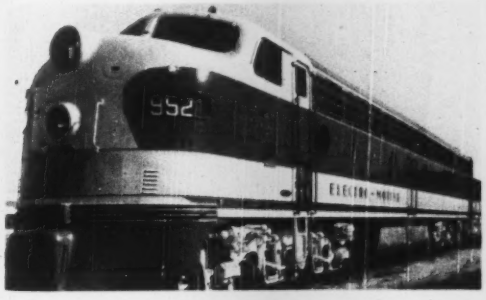


FIG. 7 GENERAL MOTORS 2250-HP PASSENGER UNIT

TABLE 2 ELECTRIC LOCOMOTIVES

Railroad	French National Rwys.	Chilean State Rwys.
Builder, mechanical	Alsthom (France)	General Electric Co.
Builder, electrical	Alsthom	General Electric Co.
Wheel arrangement	C-C	B-B
Service	Passenger	Road-switching
Power supply	1500 volt, d-c	3000 volt, d-c
Current collector	Pantograph	Pantograph
Driving wheels:		
Number	12	8
Diameter, in.	49 1/8	37 1/4
Weight, lb:		
Total	222500	154000
On drivers	222500	154000
Per driving axle	37080	38500
Dimensions, ft-in.:		
Length over-all	61-0	41-10 1/2
Width over-all	—	10-0
Height, pantograph down	—	14-7
Rigid wheel base	15-11	8-0
Total wheel base	46-5	29-0
Traction motors:		
Number	6	4
Method of mounting	Frame	Axle-hung
Method of drive	Flexible-geared	Single-reduction
Gear ratio	—	68/15

Railroad	French National Rwys.	Chilean State Rwys.
Builder, Mechanical	Alsthom (France)	General Electric Co.
Builder, Electrical	Alsthom	General Electric Co.
Tractive force:		
One-hour rating, lb	34800	23800
Per cent adhesion	13.62	15.40
Continuous rating, lb	30800	19520
Per cent adhesion	13.85	12.70
Horsepower:		
One-hour rating	4540	1484
Continuous rating	4300	1272
Speed, mph:		
One-hour rating	49.0	23.4
Continuous rating	52.4	24.4
Maximum speed, mph	110	50
Equipped for regeneration	No	No
Equipped for multiple-unit operation	No	No
Track gage, in.	56 1/2	66

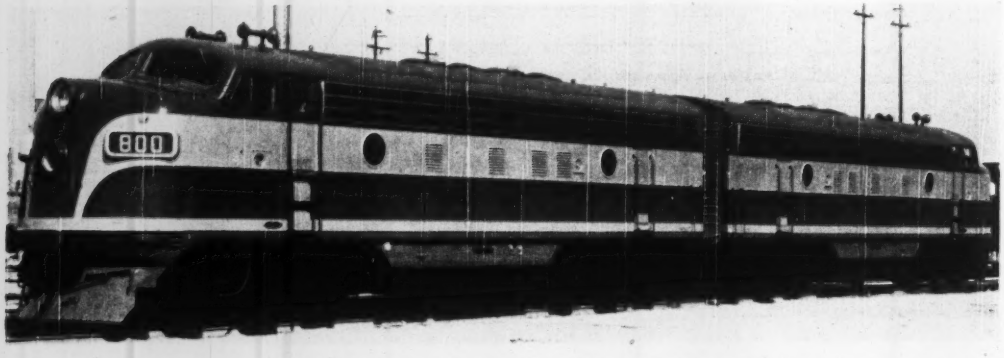


FIG. 8 3000-HP HEAVY-DUTY FREIGHT AND PASSENGER LOCOMOTIVE

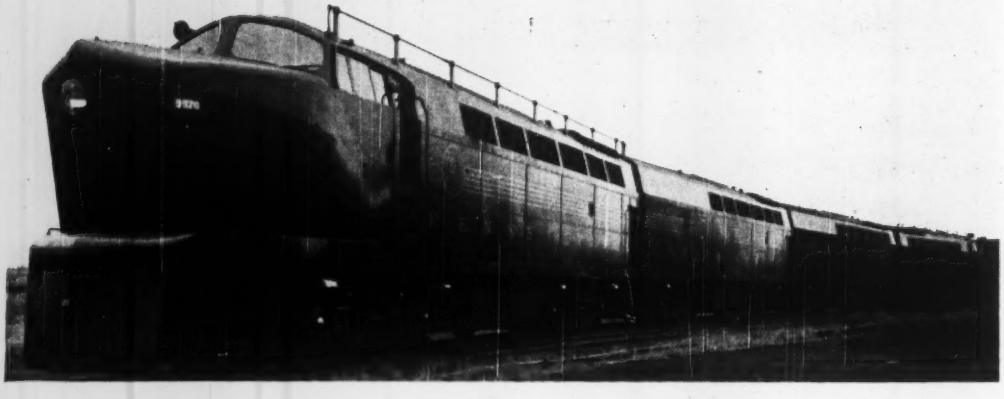


FIG. 9 BALDWIN 6000-HP FREIGHT LOCOMOTIVE

TABLE 3 DIESEL LOCOMOTIVES

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11
Builder	Gen. Motors	Gen. Motors	Gen. Motors	Baldwin Loco.	Baldwin Loco.	Lima-Hamilton	ACF[a]	English Elec.	General Electric	Sweden[f]	Whitcomb
Owner	Various	Various	Various	Penna. R. R.	Union R. R.	Various	ACF	Egyptian State	Argentina[d]	Swedish State	Argentina
Unit wheel arrangement	A1A-A1A	B-B	B-B	B-B	C-C	B-B	B-B	1A-D-A1	A1A-A1A	A-B-A	C-C
No. of units per locomotive	1, 2, or 3	1, 2, 3, or 4	1, 2, 3, or 4	1, 2, 3, or 4	1	1	1	1	2	1	1
Total hp per unit (for traction)	2250	1500	1500	1500	1500	1000	1150[b]	12	900	900	675
Service	Passenger	Freight or pass.	Freight or pass.	Freight	Road switching	Switching	Passenger	Freight & pass.	Freight & pass.	Switching	Freight & pass.
Engine data (per unit)											
No. of Diesel engines	2	1	1	1	1	1	2[c]	1	1	2	1
Rated hp (per engine)	1125	1500	1500	1500	1500	1000	405[c]	1600	900	450	675
No. of cylinders (per engine)	12 (V-type)	16 (V-type)	16 (V-type)	8	8	8	8 (V-type)[c]	16 (V-type)	12 (V-type)	6	8
Bore and stroke, in.	$8^1/_2 \times 10$	$8^1/_2 \times 10$	$8^1/_2 \times 10$	$12^3/_4 \times 15^1/_2$	$12^3/_4 \times 15^1/_2$	9×12	$6^1/_4 \times 6$	10×12	$9 \times 10^1/_2$	$7^{11}/_{16} \times 11^{13}/_{16}$	$8^1/_2 \times 10^1/_2$
Speed (rpm)	800	800	800	625	625	1000	1800[c]	720	915	750	1100
Cycles	2	2	2	4	4	4	4[c]	4	4	2	4
Supercharged	No	No	No	Yes	Yes	Yes	Yes[c]	Yes	Yes	No	No
Manufacturer	Gen. Motors	Gen. Motors	Gen. Motors	Baldwin Loco.	Baldwin Loco.	Lima-Hamilton	Hercules	English Elec	C-B[e]	Sweden[f]	National[g]
Unit data:											
Length over-all, ft-in.	70-3	50-8	54-8	54-$4^1/_2$	58-0	47-10	43-$5^3/_4$	59-8	47-8	42-$7^3/_4$	48-$4^1/_2$
Rigid wheel base, ft-in.	14-1	9-0	9-0	9-10	13-0	8-0	7-9	16-0	10-7	13-$1^1/_2$	11-$3^1/_2$
Total wheel base, ft-in.	57-1	39-0	43-0	38-0	44-6	32-6	23-6	48-11	34-1	29-$6^3/_{16}$	33-0
Weight on drivers, lb	210750	230000	258000	261340	326700	240000	135000	192000	112400	139300	150000
Total weight, lb	316500	230000	258000	261340	326700	240000	135000	246000	165000	139300	150000
Fuel capacity, gal	1200	1200	200	1200	1900	625	600	760	530	475	600
Driver diameter, in.	40	40	40	42	42	40	33	45	36	$38^3/_4$	40
Max. permissible speed, mph	117	102	89	65	60	60	105	90	90	25	57
Track gage, in.	$56^1/_2$	$56^1/_2$	$56^1/_2$	$56^1/_2$	$56^1/_2$	$56^1/_2$	$56^1/_2$	$56^1/_2$	$39^3/_8$	$56^1/_2$	$39^3/_8$

[a] American Car & Foundry Company.
[b] Two engines for Diesel-electric traction (total 810 hp); two engines for auxiliary power (total 340 hp).
[c] Data on traction engines.
[d] Argentine State Railways.
[e] Cooper-Bessemer Corp.
[f] Nydqvist & Holm Aktiebolag.
[g] National Supply Company Superior engines.

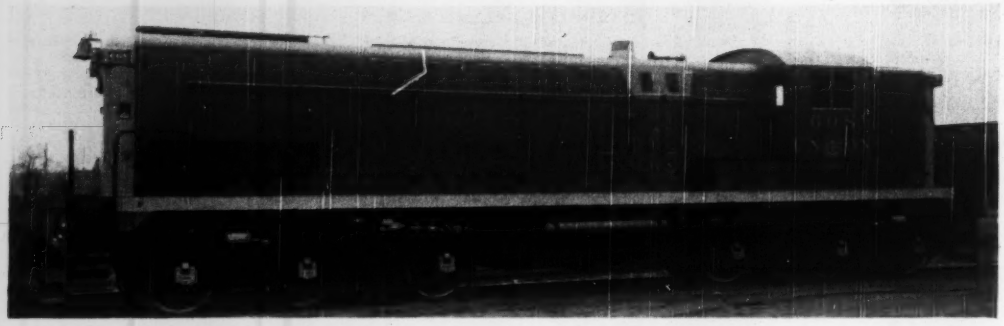


FIG. 10 1500-HP SIX-AXLE ROAD SWITCHER

FIG. 11 LIMA-HAMILTON 1000-HP SWITCHER

FIG. 12 HIGH-SPEED LIGHTWEIGHT ACF-TALGO TRAIN

also a new feature of the train. The four Diesel engines were manufactured by Hercules Motors Corporation, and the primary electrical equipment was furnished by the General Electric Company. Illustrated in Fig. 12, details of the locomotive are given in Table 3, item 7.

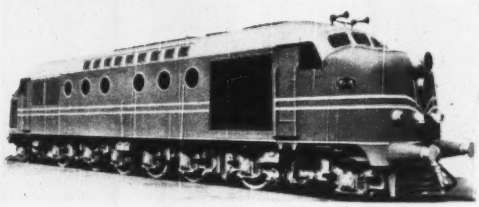


FIG. 13 1600-HP ROAD LOCOMOTIVE FOR EGYPT

The English Electric Company has built twelve 1600-hp Diesel-electric locomotives for the Egyptian Government. One of these is shown in Fig. 13, and details are given in Table 3, item 8. Having a power plant similar to the two road Diesel-electrics built by the same company for the British Railways, and described in the report of this Committee last year, the running gear of the Egyptian locomotives is unusual in that six motored axles are used—an arrangement whereby there is one motored axle and one idle axle on both the lead and trailing trucks.

During the year, the first group of an order for 35 two-unit Diesel-electric locomotives was furnished the General Belgrano Railroad of Argentina. Illustrated in Fig. 14, these 1800-hp locomotives are described in Table 3, item 9.

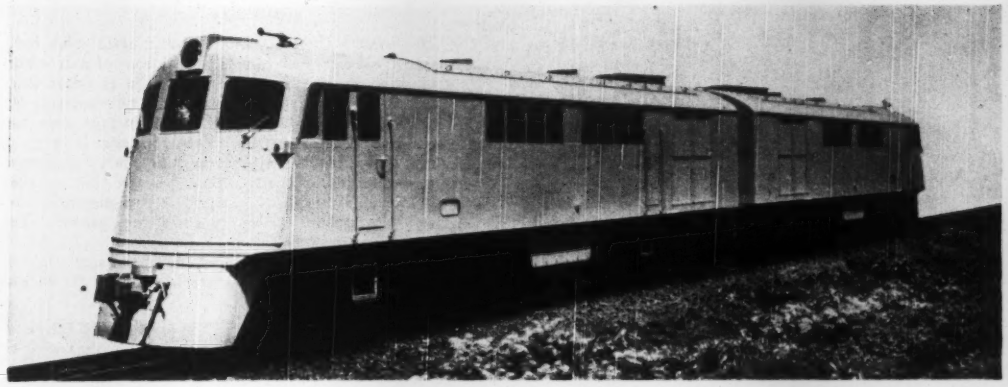


FIG. 14 1800-HP LOCOMOTIVE FOR ARGENTINA

FIG. 15 SWEDISH 900-HP DIESEL-HYDRAULIC SWITCHER

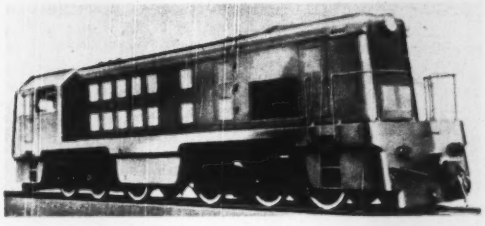


FIG. 16 675-HP ROAD LOCOMOTIVE FOR ARGENTINA

A four-axle switcher with an unusual A-B-A truck arrangement has been built for experimental service on the Swedish State Railways. The two 450-hp engines drive all axles by means of hydraulic torque converters directly coupled to the engines and combined with the reversing gear. The unit is shown and described in Fig. 15, and Table 3, item 10, respectively.

Fig. 16, Table 3, item 11, illustrates and describes one of an order for 75 Diesel-electric road locomotives currently being shipped to Argentina. This meter-gage locomotive weighs 150,000 lb with all weight on drivers.

GAS-TURBINE LOCOMOTIVE

One of the gas turbine-electric locomotives reported in last year's report as a project became a reality during the year. The 4500-hp 253-ton unit, shown in Figs. 17 and 18, and described in Table 4, ran on the Erie Works' test track of the General Electric Company on November 14, 1948, and to date has seen demonstration service on three American railroads. This is the first gas turbine - electric locomotive to be built and operated in the United States.

TABLE 4 GAS-TURBINE LOCOMOTIVES

Builder	General Electric
Owner	General Electric
Wheel arrangement	B-B-B-B
No. of units per locomotive	1
Total locomotive hp (for traction)	4500
Service	Freight
Power-plant data:	
No. of turbines	1
Horsepower per turbine	4800
Type of turbine	Impulse
No. of stages	2
Speed, rpm	6700
No. of compressors	1
Type of compressor	Axial-flow
No. of stages	15
No. of generators	4
Generator speed, rpm	1600
Fuel oil	Bunker C
Regenerator	None
Turbine builder	General Electric
Locomotive length over-all, ft-in.	83-7 1/2
Rigid wheel base, ft-in.	9-4
Total wheel base, ft-in.	68-3
Weight on drivers, lb	506000
Total locomotive weight, lb	506000
Fuel capacity, gal	6500
Driving wheels:	
Number	16
Diameter, in.	42
Track gage, in.	56 1/2
Maximum permissible speed, mph	69

The unit is designed primarily for freight service—no train-heating equipment is provided—and is geared for a top speed of 69 mph.

The turbine-compressor set is started and brought up to speed by using one of the four traction generators as a starting motor powered from a small Diesel-generator set carried on the locomotive. This set is also used for furnishing traction power to one of the traction motors to facilitate hostling and shop-yard movements of the locomotive when the turbine generator is not running. A 1600-lb steam generator is employed to heat the bunker C fuel oil under ambient temperature conditions not conducive to ready fuel-oil flow.

Details of design, construction, and equipment of the loco-

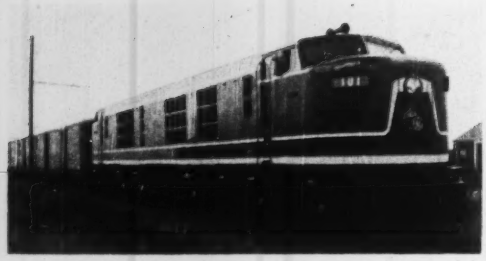


FIG. 17 GAS TURBINE-ELECTRIC LOCOMOTIVE WITH TRAIN

RAIL CARS

Fig. 19 shows a three-car Diesel-electric train with individually powered cars, each of which has a control station and power plant at one end, permitting operation as single units when desired. Built by the Davenport-Besler Corporation for the National Railways of Colombia, the 36-in-gage train has seven-step electric braking necessitated by the long steep grades over which the cars will operate. One car, a passenger-buffet-baggage car weighing 100,000 lb has two power plants with all four axles motored. The other two passenger cars have single power plants and one powered truck per car. The latter cars weigh 78,000 lb each.

The Budd Company has introduced the first of a new line of Diesel rail cars. Built of stainless steel, this 85-ft car weighs

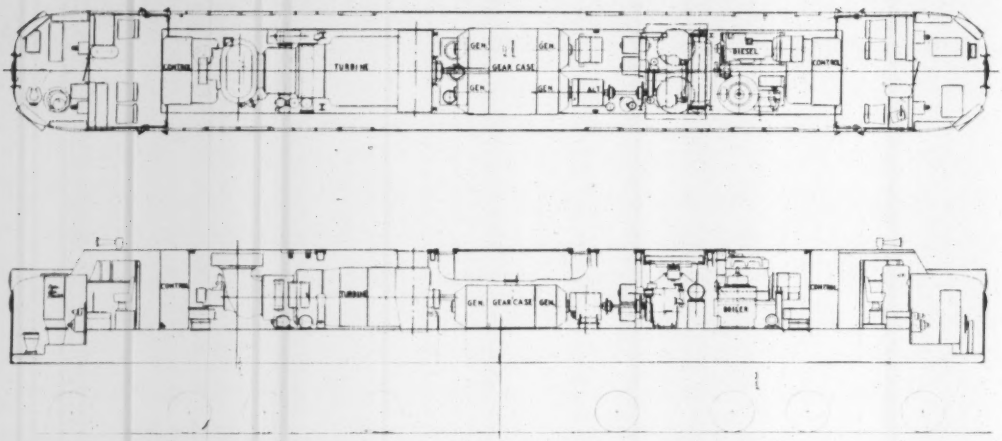


FIG. 18 DISPOSITION OF EQUIPMENT IN LOCOMOTIVE SHOWN IN FIG. 17

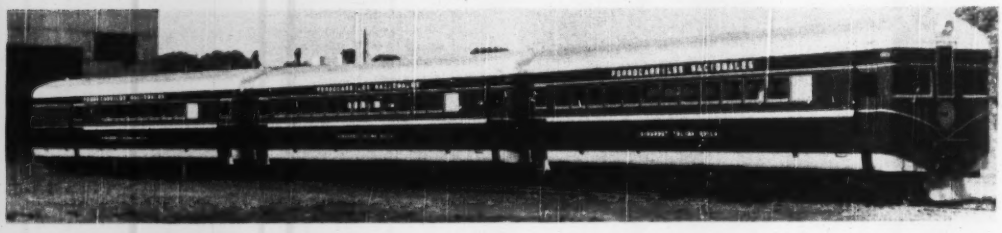


FIG. 19 DIESEL-ELECTRIC TRAIN FOR COLOMBIA

motive have appeared in papers presented at Society meetings during the past 2 years.[2]

[2] "A Gas-Turbine Electric Locomotive," by A. H. Morey.
"Controls for a Gas-Turbine Electric Locomotive," by T. J. Wartick.
"Rotating Electric Equipment for a Gas-Turbine Electric Locomotive," by O. C. Coho.
The three foregoing papers were presented at a joint ASME-AIEE local meeting, Erie, Pa., June 24, 1948.
"Design Features of a 4800-Hp Locomotive Gas-Turbine Power Plant," by Alan Howard, MECHANICAL ENGINEERING, vol. 70, 1948, pp. 301–306.
"Test of a 4800-Hp Gas-Turbine Power Plant," by Alan Howard and B. O. Buckland, presented at the Annual Meeting, November 28–December 3, 1948, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

107,900 lb and will seat 90 passengers. Power is provided by two 275-hp General Motors engines each driving one axle of each truck. The six-cylinder, in-line engines have been placed at an angle of 20 deg and are mounted under the car floor. The blister in the roof of the car, Fig. 20, houses the engine radiators and exhaust ports. The transmission consists of a torque converter which operates during acceleration up to a designated speed, at which point the transmission automatically locks into direct drive. Budd disk brakes have also been applied to the car. Capable of a maximum speed of 83 mph, the car can operate independently, or as many units as desired can be combined into a train and operated from a single position.

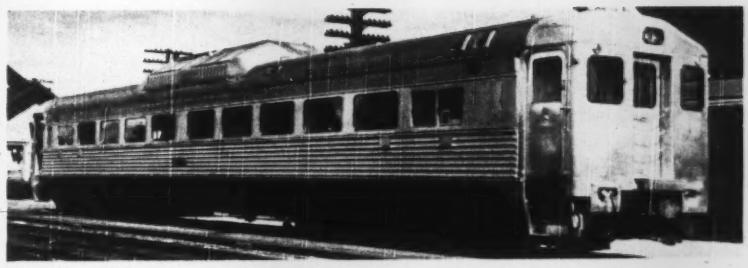


FIG. 20 SELF-PROPELLED DIESEL RAIL CAR

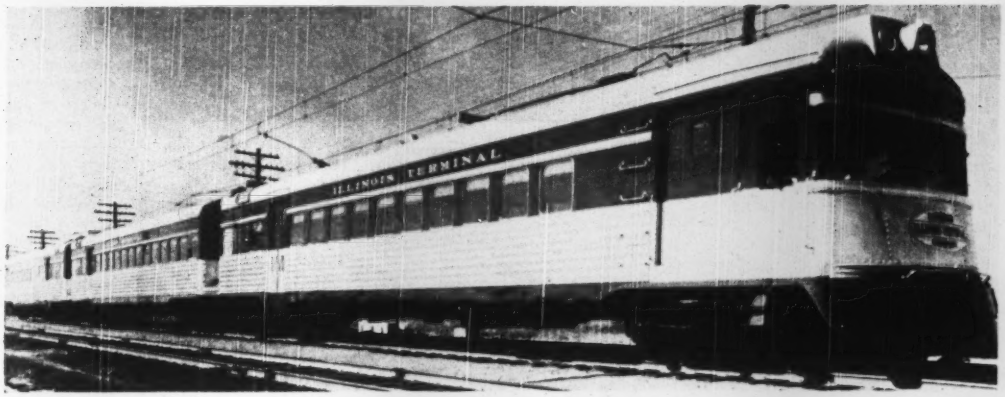


FIG. 21 600-VOLT D-C ELECTRIC TRAIN

Three new all-electric trains, built by St. Louis Car Company, and powered by General Electric traction equipment, have been placed in service on the Illinois Terminal Railroad. Each of the lead cars has four traction motors, while trailing cars have two motors each. Truck-frame mounted, the motors drive the axles through a flexible coupling and a single-reduction-gear unit. All current from the 600-volt d-c overhead is collected through the trolley on the head-end car. One of these high-speed trains is illustrated in Fig. 21.

MISCELLANEOUS DEVELOPMENTS

A new locomotive-testing station was opened during the year at Rugby, England. It has been planned by the British Railroads that Rugby will become the main center for locomotive research. The plant, illustrated in Fig. 22, can test locomotives up to 4500 hp at a maximum speed of 130 mph. Of the seven pairs of rollers which support the locomotive, any number up to five pairs can be driven by coupled wheels.

Fig. 23 shows an engineering test car built during the year by General Motors' Electro-Motive Division. When cut-in between any two units of a Diesel-electric locomotive, its equipment indicates and records practically every phase of locomotive performance capable of measurement by sensitive electrical instrumentation. It was designed to extend research and test work on modern locomotives beyond the confines of stationary laboratories and testing equipment.

PROJECTED MOTIVE-POWER DEVELOPMENTS

While it is the prime purpose of this Committee to report accomplished progress in railway mechanical engineering, it is felt that brief mention of developments in project, but not completed, are indicative of trends and of progress also. Hence the following paragraphs give a brief review of major development projects that have come to the attention of the Committee.

The Norfolk & Western Railway has ordered a 4500-hp coal-burning, steam turbine-electric freight locomotive to be built by Baldwin Locomotive Works in collaboration with Westinghouse Electric Corporation and Babcock & Wilcox Company. The design will make use of a 600-psi boiler pressure, combined with efficiencies inherent in the steam turbine-electric drive to produce an over-all thermal efficiency which is expected to make an appreciable reduction in operating costs as compared to those experienced with the conventional steam locomotive. The locomotive will have a B-D-D-B wheel arrangement, and will have a separate water-carrying tender. Twenty tons of coal will be carried in the nose ahead of the operator's cab. The locomotive and tender in working order will weigh approximately 952,000 lb and will be 148 ft in length. The locomotive is scheduled for completion in the latter part of 1950.

The Pennsylvania Railroad placed orders during the year for four experimental 11,000-volt a-c electric freight locomotives. Baldwin-Westinghouse will build two two-unit 5625-hp locomotives. Each unit of one locomotive will have three 4-wheel trucks and each unit of the other locomotive will have two 6-wheel trucks. General Electric will build two two-unit 5000-hp locomotives, each unit having two 4-wheel trucks.

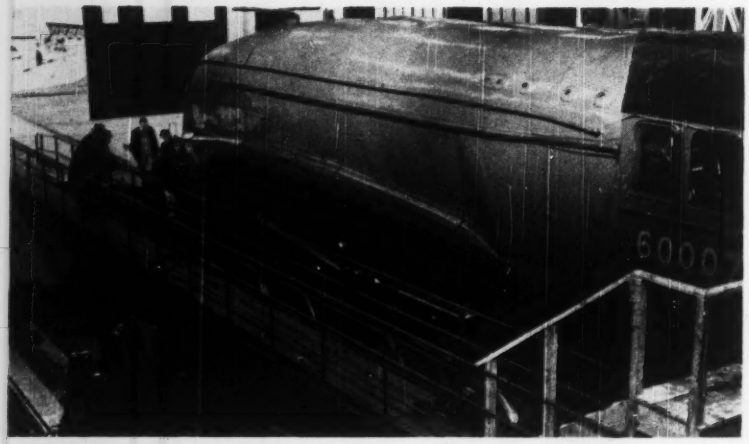


FIG. 22 BRITISH RAILWAYS TESTING PLANT

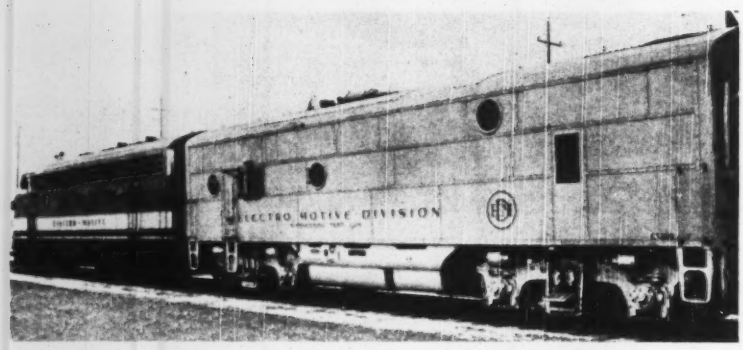


FIG. 23 ELECTRO-MOTIVE ENGINEERING TEST CAR

The British Railways have under construction a 2000-hp 2-D-2 Diesel-mechanical freight and passenger locomotive. Four supercharged engines, each developing 500 hp to be housed in pairs at either end of the two-directional operating cab located in the center of the locomotive, will be coupled to the driving wheels through fluid couplings and a gearbox in such a way that main-engine horsepower is maintained as constant as possible over the designed range of engine speeds. The locomotive will have a maximum speed of 84 mph.

Fairbanks, Morse & Company has under construction the first of a new line of Diesel-electric freight and passenger locomotives. Designated as the Consolidation line, various power-plant ratings of 1600 hp, 2000 hp, or 2400 hp can be installed in a single unit with no change in the general arrangement of the basic structure. The three variations of horsepower ratings can be coupled in combinations from 1600 hp to at least 9600 hp in a single locomotive.

Construction and development continue on a number of experimental gas turbine-electric locomotives.

The Locomotive Development Committee of Bituminous Coal Research, Inc., which is working on the development of a gas turbine-electric locomotive to burn pulverized coal, has reached the stage in the solution of its problems where a gas turbine actually will be run on the test floor in the near future. To expedite the work this test operation will be on a nonregenerative cycle. When built, the locomotive will be operated on a regenerative cycle. The fuel system will be at atmospheric pressure until the pulverized coal is pressurized for delivery to the combustion chamber.

One of the major problems in this development has been the construction of a long-life "coal pump" for getting the coal under pressure. This is now reported to be solved. The cold-wall combustor is showing good efficiencies with a minimum of distortion. Work is also progressing on the development of a hot-wall combustor, i.e., a combustor with a refractory lining. The hot-wall combustor is reported as showing uniformly higher combustion efficiencies than the cold-wall type, and apparently it is less sensitive to coal-particle size. A further advantage of the hot wall is that about one half of the ash is drawn off in the form of slag, and the difficulties of cleaning the gas stream are reduced proportionately.

The laboratory tests to be run are practically full-scale tests of the equipment to go into the locomotive. These tests are expected to furnish the answer as to whether a small percentage

of very fine ash particles in the gas stream, which cannot be removed economically, are harmful to a gas turbine.

A 4000-hp double turbine-compressor locomotive with a B-B-B-B wheel arrangement is nearing completion in the plant of the Westinghouse Electric Corporation at Pittsburgh, Pa.

Delivery is expected early in 1950, of a 3750-hp, 2-D + D-2 gas turbine-electric locomotive being built by Baldwin for the Santa Fe, and to be equipped with an Elliott turbine-compressor and Elliott electrical equipment. The unit will employ a centrifugal compressor.

The Western Region of the British Railways has on order and prospects for 1950 delivery of two gas turbine-electric locomotives. One is being built by Metropolitan-Vickers of England, while the second is being built by Brown-Boveri and the Swiss Locomotive and Machine Works in Switzerland.

Lima-Hamilton Corporation has under development a 3200-hp locomotive to employ a free-piston type of compressor.

Westinghouse Electric Corporation, in collaboration with the Pennsylvania Railroad, has under test a multiple-unit car, operating from an 11,000-volt 25-cycle single-phase contact system, equipped with sealed Ignitron mercury-arc-rectifier tubes feeding two standard 230-hp 650-volt d-c traction motors. Laboratory tests indicate that these rectifiers will function successfully in spite of shock and vibration incident to rail-car operation. The objective of the undertaking is to combine the advantages of an alternating-current contact system and direct-current traction-motor characteristics which will result in a conventional equipment with relatively light weight and high efficiency. Another advantage will be the ability to use commercial frequency on the contact system.

The Association of American Railroads has a program under way for the general study of refrigerator cars and their operation. About 15 years ago a number of railroads and private car lines were interested in the possibilities of some form of cooling other than ice. In the late 1930's a number of test cars were built. These studies were dormant during the war. At present there is an increasing need for other than water-ice refrigeration. The shipment of frozen foods which requires zero temperatures has accelerated this demand. Formerly, only meats were shipped at this low temperature and water-ice and brine salt provided a satisfactory cooling medium. Both railroads and refrigeration manufacturers are working on this problem. The schemes under consideration include the use of dry ice to cool a secondary cooling medium, which in turn cools the car; the use of ammonia stored in tanks under the car to absorb water from cooling coils in the car, whereby the resulting evaporation of water from the coils cools the car; and use of a commonplace compression refrigerant system with power derived from a Diesel engine.

PASSENGER CARS

During the past year the efforts of the car builders and railroads have been directed toward completion and delivery of the large accumulation of orders placed after the war. Progress in this direction is evidenced by the fact that less than 1200 passenger cars now remain to be completed by the industry out of a total of 4000 cars ordered since the war.

The year also brought to completion a number of orders or projects of particular interest from the construction standpoint.

The Southern Pacific took delivery of new equipment from Pullman-Standard for the "Shasta"—a train operating between San Francisco and Portland, Oregon—and also some miscellaneous equipment for operation of the "Daylights." The Shasta cars were built of aluminum-frame superstructures with steel underframes, while the other cars were built of all-welded steel. One of the particular features of the new Shasta cars is the extra large windows, Fig. 24.

These trains also feature a three-car articulated dinner-kitchen-coffee shop unit which is shown in Fig. 25. The kitchen is, in the center car. One end unit contains the dining car, and the other end contains the coffee shop. Passage between cars is through a wide opening with insulated rubber diaphragms sealing the space between cars. For practical purposes, the three units present one continuous interior.

During the past year additional "dome-type" cars were placed in service on the Budd-built "California Zephyrs" which operate between Chicago and San Francisco. On these trains all cars other than the sleepers have a dome. This type of car was described in detail in the report of this Committee two years ago.[3]

A dome-type coach was also introduced on each of the new Pullman-built Baltimore and Ohio "Columbians" operating between Chicago and Washington.

[3] "Progress in Railway Mechanical Engineering, 1946-1947," MECHANICAL ENGINEERING, vol. 70, 1948, pp. 321-335.

FIG. 24 SOUTHERN PACIFIC SHASTA COACH

FIG. 25 THREE-UNIT DINER FOR SOUTHERN PACIFIC

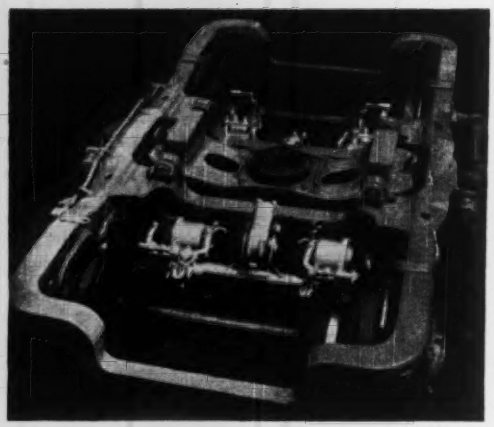


FIG. 26 PASSENGER-CAR TRUCK INCORPORATING DISK BRAKES

Budd disk-type brakes were applied to a large number of cars during the past year in place of the customary wheel-tread type of brake. A truck to which this type of brake has been applied is shown in Fig. 26.

In the export field Budd completed 63 cars for the Central Railway of Brazil. This contract included eight different types of cars which were completely modern in every respect. Their equipment and appointments compare closely with cars provided for main-line service in North America. They have the AAR standard cross section and, except for the mail-storage car, are 85 ft long. They are provided with air conditioning. Heating is not required because of the mild climatic conditions under which these cars will operate.

During the year, Pullman-Standard completed 22 second-class coaches for the Manila Railways in the Philippines. These cars are very close in dimensions to the standard United States cross section for lightweight cars. Being designed as second-class coaches they are not air conditioned and are equipped with the wooden-type seats still common in foreign countries for second and third-class cars.

An all-electric dining car has been placed in service by the Illinois Central. This car is 85 ft long and is built of Cor-Ten steel. Seating 36 persons, the car was built by the Illinois Central in co-operation with the General Electric Company. The weight of the car is 157,560 lb. Electric power generating and conversion equipment consists of two model 6BD-230 Buda Diesel engine-alternator sets furnishing 220-volt 3-phase 60-cycle power; a motor generator set with a 220-volt 3-phase 60-cycle motor and direct-current generator for battery charging; and necessary control equipment. The power plants are mounted on vibration dampers in a housing below the car. Each power unit can be swung to the outside and beyond the edge of the car for servicing without making any disconnections other than those of the exhaust pipe. Heat exchangers, provided to heat water for kitchen use, utilize exhaust gases from each engine. The power plants provide up to 50 kw which is used for the latest advancements in electrical kitchen appliances, including cooking and refrigeration, as well as lighting and air conditioning for the cars, Fig. 27.

The Pennsylvania has provided for future electric kitchens in some of its diners completed by the Budd Company. In this case, one 25 to 30-kw axle-driven motor generator set was applied under the car and provision made for a second 25 to 30-kw axle-driven generator set to be driven from the other truck when the coal-burning ranges are replaced with electric units. The refrigerators, coffee urns, broiler units, and dishwasher are electrically operated at the present time.

The most unusual train brought out during the past year was the American Car and Foundry's ACF-Talgo train, the Diesel-electric locomotive having been described previously in this paper.

The cars of this train include some novel concepts in car design and construction. Each car or unit is about 20 ft long and seats 16 passengers, Fig. 28. The rear unit is 7 ft longer to accommodate the observation overhang. In contrast to conventional streamline equipment on the domestic railroads today, the floors are 2 ft 9 in. lower, and, considering locomotive and cars, a weight reduction of nearly 50 per cent per passenger seat has been accomplished. Besides the locomotive, the train consists of baggage and five coach units, the last unit of which features an observation lounge. The over-all length of the train is 167 ft 6½ in. Entrance to the coaches is gained through the equipment unit. This unit, being located in the center of the train, contains air conditioning, kitchenette, control lockers and washrooms, which serve the entire train.

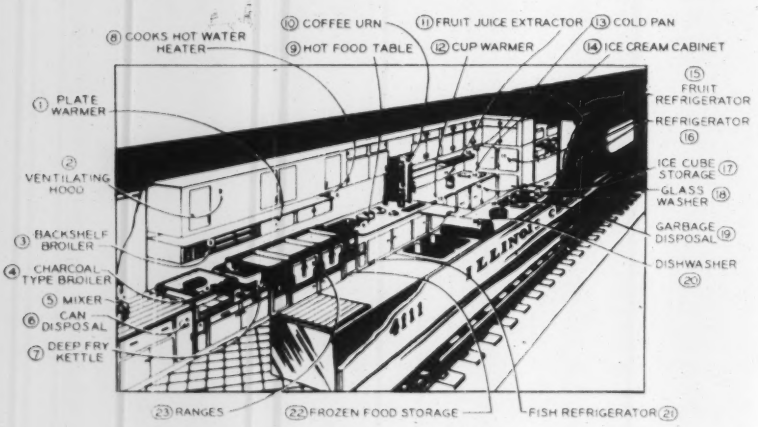


FIG. 27 ILLINOIS CENTRAL ALL-ELECTRIC KITCHEN

One of the unique features of this train is the fact that each unit has only one pair of wheels. The front end of a unit is supported by a special coupling arrangement on the unit ahead of it, while the front end of the first unit is supported by the locomotive, which has a conventional B-B wheel arrangement.

The front of each unit is supported on the forward unit through two bearers, one being near each side of the car and each centered 32 in. above the rail. Tension between the cars is provided by a simple connection having horizontal and

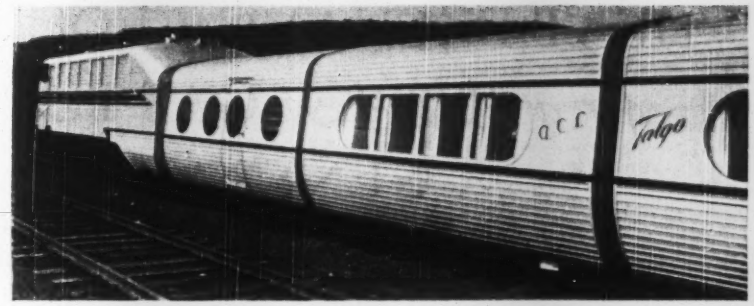


FIG. 28 ACF-TALGO TWO-WHEEL CARS AND B-B LOCOMOTIVE

vertical pins at the center line of the car just about the height of the centers of the wheels.

In the case of conventional passenger cars the wheels rotate in the vertical plane of the rail; therefore, for practical purposes, there is no friction between the rail and the wheel flange. On a curve, however, the outer wheels of a standard pivoted railway car truck tend to dig into and climb over the rail. This is known as a positive angle of attack. In this case, the flange on the outside forward wheel is rubbing against the rail in a downward direction, and the forces set up as a result of this friction tend to lift the car from the rail. In the case of the ACF-Talgo cars, this positive angle of attack on the outer rail is eliminated as the wheels are led around the curve through the use of the three-point geometry of the underframe, similar to the way in which a trailer follows behind a truck-tractor. The unit, therefore, is pulled into a curve inwardly, to a very slight degree, by the preceding unit which is already on the curve. The leading edge of the flange of the outside wheel is pulled away from the rail, resulting in a negative angle of approach. The derailing force is thereby eliminated. On sharp curves and at high speeds the trailing edge of the wheel flange rubs against the outside rail with a force which pulls the unit downward.

Suspension springs of the ACF-Talgo equipment are carried from their supports up to the sides of the car to a point approximately 40 in. above the top of the rail or 22 in. above the floor of the car. The center of gravity of the car is at approximately the same height as the point of suspension and, therefore, the car will not swing out from the top. This spring suspension, which banks a car into a curve, plus the negative angle of approach of the wheels on the rail, is claimed to permit high speeds on curves with greater safety and passenger comfort.

When uncoupling a unit, a support, located at the forward end of the unit and having two small wheels, is dropped to the rail as illustrated in Fig. 29. The train may be operated in reverse for slow-speed yard operations.

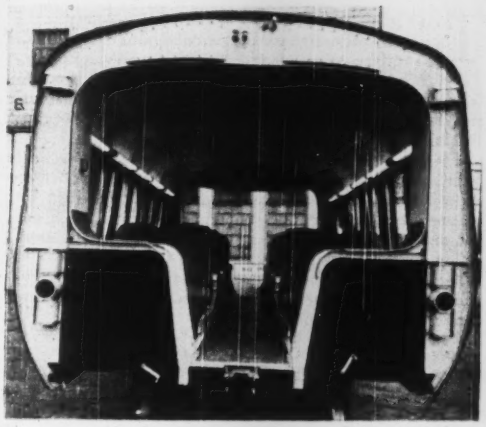


FIG. 29 DOLLY WHEELS SUPPORTING FRONT END OF DETACHED UNIT

FREIGHT CARS

Two types of cars for handling bulk flour have been introduced, one by the National Fitch Corporation, and the second by General American. It is claimed that these insulated cars will reduce the loss and damage chargeable to condensation. These cars are designed to carry approximately twice the revenue flour load that is now carried in box cars.

The National Fitch car is a two-compartment unit having each section built along the lines of a hopper car. It is loaded through two hatches in the roof of the car. The slope sheets and other interior metals are of stainless steel with welded joints ground after assembly. Unloading is done by two electrically powered traveling suction nozzles which are built into the car, one for each compartment. These nozzles extend the length of the sections. A receptacle at each end of the car connects these nozzles to a suction pipe at the receiving terminal which sucks the flour from the car.

The General American car is built more along the lines of the conventional hopper car but comprises twelve separate stainless-steel hoppers, six on each side of the car. Each hopper is loaded through a hatch in the car top. At the receiving terminal a receptacle at the bottom of the hopper is connected to a pneumatic unloading device which empties the car. This device was developed by the Fuller Company of Catasauqua, Pa.

The Union Pacific recently converted some covered hopper cars to carry bulk sugar. This was accomplished by installing a special unloading mechanism at each of the four hopper dumps. A special metal plate with studs at the bottom of the hopper receives an unloading chute which is attached at the receiving terminal.

ACKNOWLEDGMENT

The committee gratefully acknowledges the assistance in securing data for the report rendered by the railway press of the United States; by the *Railway Gazette* of Great Britain; by the various railroads, locomotive, car and railway-equipment manufacturers; by the British Railways; by the French National Railways; by the English Electric Company, Ltd.; by the Vulcan Foundry, Ltd.; and by Nydqvist & Holm Aktiebolag.

HEAT-EXCHANGE EQUIPMENT *for a* 5000-Kw GAS-TURBINE GENERATOR

By GEORGE R. FUSNER

GAS TURBINE ENGINEERING DIVISION, GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y. JUN. ASME

INTRODUCTION

THIS paper describes the heat-exchange equipment and discusses the design considerations of this equipment for a gas-turbine power plant described in a previous paper.[1]

Fig. 1 is an artist's conception of the power plant from drawings. It can be seen from this illustration that two regenerators and two intercoolers in parallel have been used. The intercoolers are marked with the letter A and the regenerators with the letter B. If the regenerator were made in one piece, it would be about the same length and about 1.4 times the diameter. Since this power plant was designed for a basementless building, the split arrangement is much neater and makes possible a symmetrical design of inlet and exhaust casings for the rotating machinery.

This power plant is schematically shown in Fig. 2, with numbers indicating the temperatures, pressures, and flows at the design "full-load" point.

INTERCOOLERS

Reduced compressor-inlet temperature, which results from intercooling, reduces the amount of work required to drive the high-pressure compressor. Since this compressor is attached to the load shaft, it means that there will be more power-plant output for a given turbine output. This effect on cycle performance is larger than that of the heat lost in the intercooler. The net effect is to increase the cycle efficiency.

The intercooler between the low- and high-pressure compressors reduces the volume flow to the high-pressure compressor. This makes it smaller in size and lower in cost. Intercooling increases the net work per pound of air flowing in cycle. Thus, for a given power-plant output the size and cost of all the machinery can be reduced with intercooling.

Actual values for this net work are shown in Fig. 3, which assumes that the intercooler air-pressure drop is proportional to the effectiveness. It can be seen from this curve that the net work of the cycle is increased from 48 Btu per lb to 71 Btu per lb, or 48 per cent by adding a 90 per cent effective intercooler. Also shown in this figure is the change in cycle efficiency resulting from varying the size of intercoolers. This curve shows that the addition of a 90 per cent effective intercooler raises the thermal efficiency from 19.8 per cent to 28 per cent. These curves are not general, but only apply to the

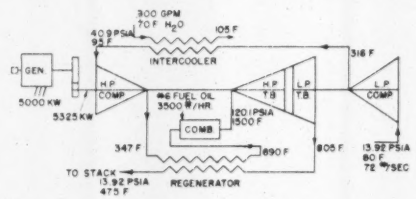


FIG. 2 CYCLE DIAGRAM WITH PERTINENT PRESSURES, TEMPERATURES, FLOWS, AND OUTPUT FOR DESIGN RATING AT 1500 FT ALTITUDE

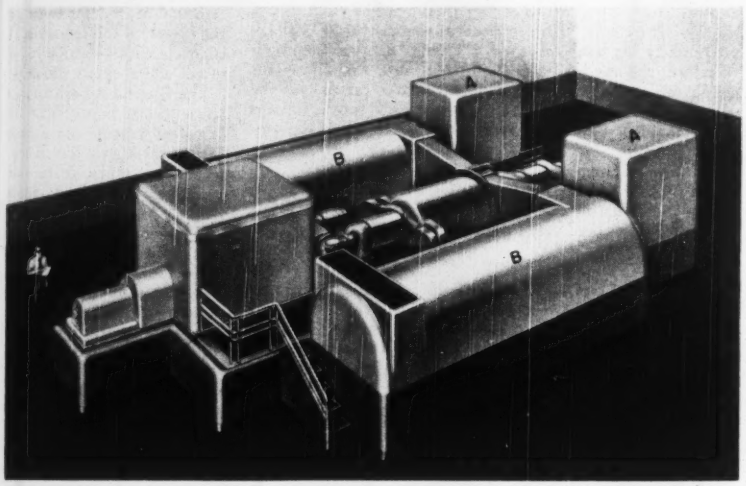


FIG. 1 ARTIST'S CONCEPTION OF 5000-KW GAS-TURBINE POWER PLANT

[1] "A 5000-Kw Gas Turbine for Power Generation," by Alan Howard and C. J. Walker, Digest published in MECHANICAL ENGINEERING, vol. 71, 1949, p. 38.

Contributed by the Heat Transfer Division and presented at the Annual Meeting, New York, N. Y., November 27–December 2, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

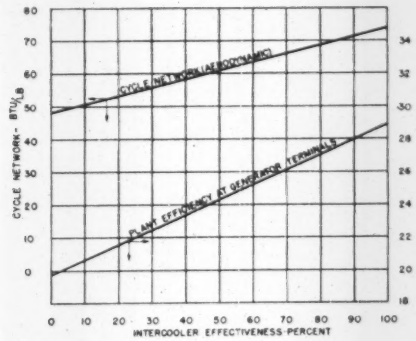

CYCLE NETWORK - BTU/LB
CYCLE (NET WORK LESS COMPRESSOR)
PLANT EFFICIENCY AT GENERATOR TERMINALS
INTERCOOLER EFFECTIVENESS-PERCENT
0 10 20 30 40 50 60 70 80 90 100
80 70 60 50 40 30 20 10 0
34 32 30 28 26 24 22 20 18

FIG. 3 EFFECT OF INTERCOOLER EFFECTIVENESS ON A 9 TO 1 PRESSURE RATIO, 1500 F GAS-TURBINE CYCLE WITH A 75 PER CENT EFFECTIVE REGENERATOR CYCLE NET WORK AND EFFICIENCY

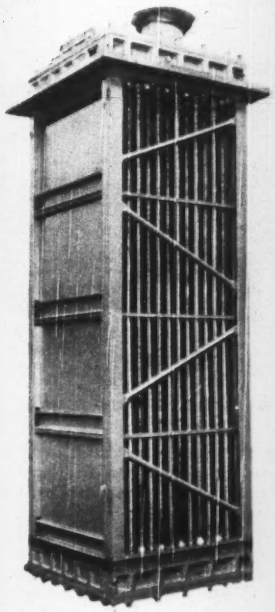


FIG. 4 INTERCOOLER SECTION

power plant under consideration, that is, a 9 to 1 pressure ratio 1500 F gas-turbine cycle with a 75 per cent effective regenerator.

It is recognized that the gains in thermal performance, due to adding both a regenerator and intercooler to a gas-turbine cycle, cannot be allocated actually to the individual pieces of equipment, and the cycle pressure ratio is properly a function of heat-exchanger arrangement, effectiveness, and pressure drop, in addition to other variables. The cycle being considered was designed for both intercooler and regenerator, and its thermal performance is considerably lowered if either element is left out.

As is usually the case with liquid-to-gas heat exchangers, extended surface turned out to be the most economical. The design worked out such that standard generator air coolers could be used. For the reasons given in the "Introduction," the intercoolers were split in half. To use existing patterns two sections were placed in series in each casing. The water connections were also made for series flow.

Fig. 4 shows one of the intercooler sections. Each section contains 150 tubes, 6 ft 6 in. long between tube sheets with 2630 sq ft of air-cooling surface; $^3/_8$-in-high fins are spiral-wound and soldered with a spacing of 9 per in. to 1 in. Admiralty metal or copper tubes. There are two passes on the water side of each section, and one on the air side. Each section is 2 ft $4^3/_8$ in. wide, 2 ft $4^7/_8$ in. deep, and 8 ft $3^3/_8$ in. overall height. Typical expected performance for two sections in series is given in Table 1.

TABLE 1 EXPECTED PERFORMANCE OF TWO INTERCOOLER SECTIONS IN SERIES

Heat transferred, Btu per hr	6,921,450
Air flow, lb per sec	36
Air-inlet temperature, deg F	316
Air-outlet temperature, deg F	95
Air-pressure drop, psi	0.35
Water flow, gpm	400
Water-inlet temperature, deg F	70
Water-outlet temperature, deg F	104.7
Water-pressure drop, psi	1.7
Over-all heat-transfer coefficient, Btu/hr/sq ft/deg F	15.0
Water mass velocity, lb/sq ft/sec	165.5
Air mass velocity, lb/sq ft/sec	5.7

An effectiveness of 90 per cent was chosen for this power plant. For those not familiar with this term, "effectiveness" is defined as the ratio between the actual temperature drop of

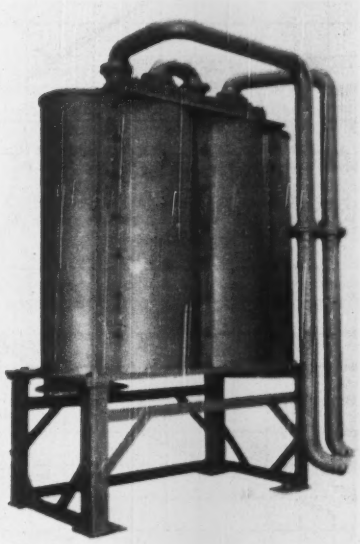


FIG. 5 INTERCOOLER SECTIONS ASSEMBLED IN CASING WITH WATER CONNECTIONS MADE

the air and the temperature drop of the air if it were cooled down to the inlet-water temperature.

Fig. 5 shows two of the intercooler sections assembled in a casing with the water connections made. It can be seen in this view that an attempt was made to keep the casing around each section as nearly round as possible to hold the 27-psig air pressure. Stays were also used on each side of the sections to help hold the pressure. Both the air inlet and outlet connections are made at the bottom. This allows the connecting ducts to be concealed below the operating level of the power plant.

Since a change in water temperature affects the high-pressure-compressor inlet temperature, the performance of the plant is also affected. For the design ambient temperature of 80 F the variations in output and heat rate are shown in Fig. 6. These curves are based on the assumption that the high-pressure-compressor inlet guide vanes are adjusted to maintain 1500 F at the turbine inlet as the cooling-water temperature is varied.

REGENERATORS

A regenerator is used in a gas-turbine cycle to remove heat from the turbine-exhaust gas and transfer it to the air entering the combustors. Thus less fuel need be burned to obtain a given output. Fig. 7 shows how the 5000-kw plant cycle efficiency would vary if the regenerator effectiveness were varied, assuming the air and gas pressure drops are proportional to effectiveness. It can be seen from this curve that the addition of the 75 per cent effective regenerator increased the expected thermal efficiency from 21.1 per cent to 28 per cent.

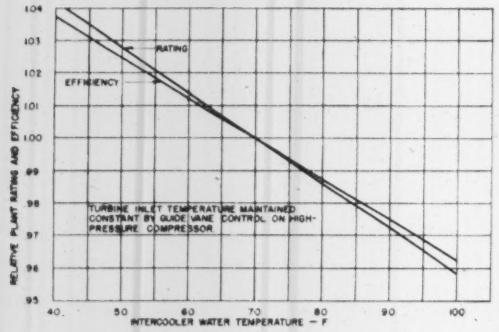

RELATIVE PLANT RATING AND EFFICIENCY
INTERCOOLER WATER TEMPERATURE — F
RATING
EFFICIENCY
TURBINE INLET TEMPERATURE MAINTAINED CONSTANT BY GUIDE VANE CONTROL ON HIGH-PRESSURE COMPRESSOR

FIG. 6 VARIATIONS IN PLANT RATING AND EFFICENCY FOR VARIATIONS IN INTERCOOLER WATER TEMPERATURE FOR 80 F AMBIENT AIR TEMPERATURE

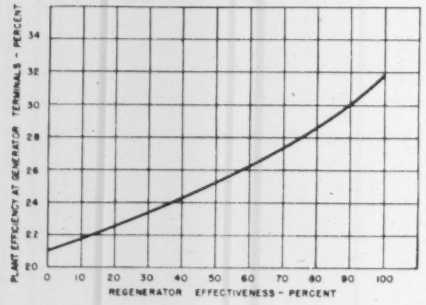


FIG. 7 EFFECT OF REGENERATOR EFFECTIVENESS ON 5000-KW POWER-PLANT CYCLE EFFICIENCY

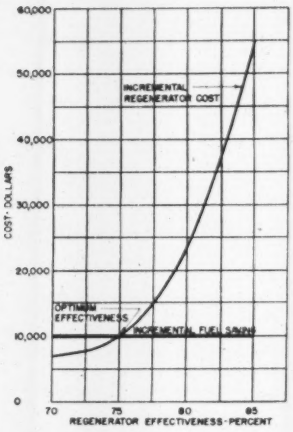


FIG. 8 INCREMENTAL REGENERATOR COST AND INCREMENTAL FUEL COST VERSUS REGENERATOR EFFECTIVENESS

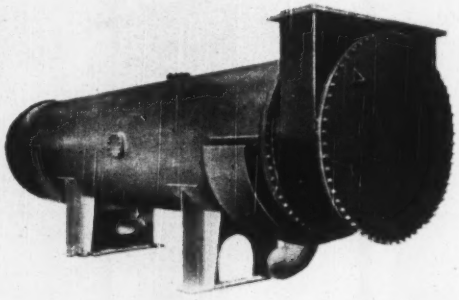


FIG. 9 OBLIQUE VIEW OF 5000-KW GAS-TURBINE REGENERATOR

In selecting the type of regenerator to be used, both bare-tube surface and extended surface were considered. To take advantage of the extended surface, the hot exhaust gases must pass on the outside of the tubes. The turbine-exhaust gas may contain ash and unburned carbon in form and quantity that are dependent upon many unknown factors. In view of the resulting uncertainty concerning tube fouling, a bare-tube design was selected. A bare-tube regenerator constructed somewhat like a condenser turned out to be the most economical and gives promise of easy maintenance.

To determine the most economical effectiveness, a plot was made of the incremental increase in regenerator cost and the incremental decrease in fuel cost. Increments of 5 per cent in regenerator effectiveness were used. Values shown in Fig. 8, are on this basis. The effectiveness at which these two curves cross is the most economical size. For these calculations it was assumed that the costs would be amortized over a 5-year period and the fuel was worth 25 cents per million Btu. A load factor of 60 per cent was also used. These are considered to be average values when taking into consideration the nationwide variations. Since the regenerator incremental-cost curve is so steep, it takes a large variation of incremental fuel

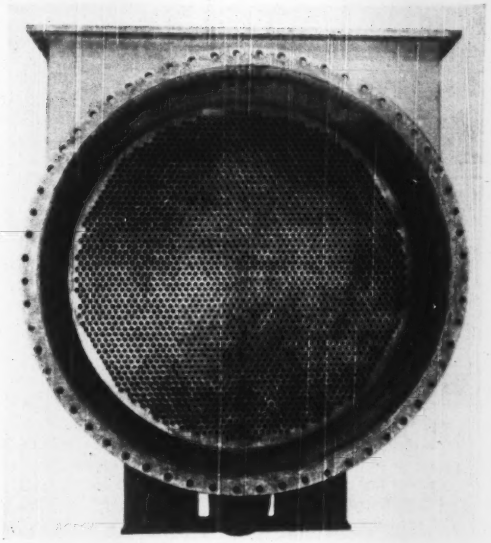


FIG. 10 END VIEW OF 5000-KW GAS-TURBINE REGENERATOR WITH END COVER REMOVED

cost to change the conclusion that a 75 per cent effective regenerator is near the optimum size.

The regenerator shown in Fig. 9, of which there are two per power plant, was designed with anticipated performance as given in Table 2.

TABLE 2 ANTICIPATED PERFORMANCE OF REGENERATOR

Heat transferred, Btu per hr	11,070,000
Air and gas flow, lb per sec	36
Air pressure entering, psia	128.1
Gas pressure entering, psia	15.69
Air temperature entering, deg F	347
Air temperature leaving, deg F	690
Gas temperature entering, deg F	805
Gas temperature leaving, deg F	475
Air-pressure drop, psia	1.7
Gas-pressure drop, psia	0.61
Over-all heat-transfer coefficient, Btu/hr/sq ft/deg F	7.95
Gas-mass velocity, lb/sq ft/sec	4.0
Air-mass velocity—cross-flow, lb/sq ft/sec	6.7
Air-mass velocity—parallel flow, lb/sq ft/sec	7.2

To obtain the performance given in Table 2, 13,100 sq ft of surface is required. This is obtained with 2500 1-in. OD No. 13 BWG carbon-steel tubes rolled into 1-in. carbon-steel tube sheets. The distance between tube sheets is 20 ft with an over-all length of 24 ft $5^{3}/_{16}$ in. A $^{5}/_{8}$-in-thick carbon-steel shell is used which has a diameter of 6 ft. Fig. 10 is an end view of the regenerator with the end cover removed, showing the 2500 tubes staggered on $1^{1}/_{4}$-in. centers.

The air inlet and discharge connections are at the bottom. There are eight baffled passes across the tubes through which the air must pass when going from the inlet to the outlet. Only one pass is made by the exhaust gas through the inside of the tubes. Exhaust gas enters the regenerator on the side and leaves at the top or the bottom at the other end. The discharge connection is designed so that it can be rotated to fit the requirements of the power-plant building. Both air and gas paths can be clearly seen in Fig. 11, which is a cross section of a regenerator used in this plant. Construction of these regenerators is in accordance with the ASME Code for Unfired Pressure Vessels, Section VIII, Paragraph V-69.

The pressure drop on the air side of the regenerator is 1.33 per cent of the absolute pressure and on the gas side it is 3.9 per cent. Loss to the gas-turbine cycle is proportional to the sum of these per cent pressure drops, or 5.23 per cent total. Therefore, a small "psi" pressure drop should be used on the gas side since its absolute pressure is low. Since the volume flow on the air side remains essentially constant at part load, while the volume flow of the exhaust gas decreases considerably, the gas-side pressure drop decreases rapidly as load is reduced. For this reason the percentage pressure drop on the gas side was made approximately three times the air side at the design full-load point. A one-point increase in percentage pressure drop means 1.05 per cent decrease in power-plant output and 0.90 per cent increase in specific fuel consumption. These same values also apply to the intercooler pressure drop on the air side.

In plants where process steam is needed in addition to electric power, the regenerators can be omitted and a waste-heat boiler substituted. For a utility where a high amortization rate and high fuel cost justifies a high-effectiveness boiler it is possible to generate 29,500 lb per hr of 200-psig or 34,800 lb per hr of 50-psig steam. This assumes a feedwater temperature of 80 F entering the economizer. It is planned to discuss this application in more detail in a paper to be presented at a future date.

LUBRICATING-OIL COOLERS

The lubricating-oil coolers used on this gas-turbine power plant are the tank type having the same general design as the standard steam-turbine oil coolers. A typical set of design performance specifications for a cooler containing 280 sq ft of oil cooling surface is given in Table 3. It should be kept in mind that these figures indicate the maximum duty which the cooler is expected to perform. Most of the operation will be with lower water temperatures. Consequently, the water flow can be reduced.

GENERATOR AIR COOLER

The generator air cooler is a standard top-mounted cooler containing 4050 sq ft of air cooling surface. Its construction is

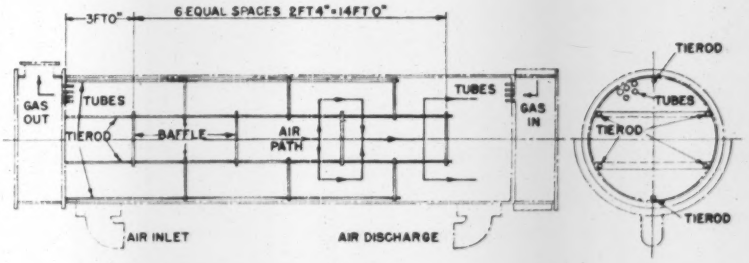


FIG. 11 CROSS SECTION OF 5000-KW GAS-TURBINE REGENERATOR

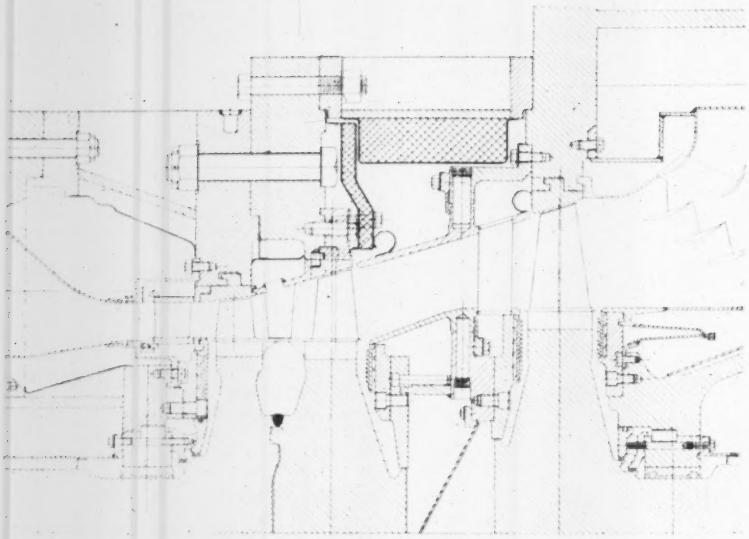


FIG. 12 CROSS SECTION OF 5000-KW PLANT TURBINE

TABLE 3 PERFORMANCE DATA FOR OIL COOLER

Heat transferred, Btu per hr	996,000
Oil flow, gpm	160
Oil-inlet temperature, deg F	180
Oil-outlet temperature, deg F	150
Oil-pressure drop, psi	10
Water flow, gpm	200
Water-inlet temperature, deg F	95
Water-outlet temperature, deg F	105
Water-pressure drop, psi	2

TABLE 4 PERFORMANCE DATA FOR GENERATOR AIR COOLER

Heat transferred, Btu per hr	837,000
Air flow, lb per sec	17.6
Air-inlet temperature, deg F	160
Air-outlet temperature, deg F	104
Air-pressure drop, in. water	0.75
Water flow, gpm	190
Water-inlet temperature, deg F	95
Water-outlet temperature, deg F	103.8
Water-pressure drop, psi	6

similar to the intercooler sections. Typical performance specifications are given in Table 4.

TURBINE COOLING PADS

The turbine wheels of the 5000-kw plant being described are cooled by water passing through pads mounted on the stationary frames beside the wheels. It can be seen from Fig. 12, that the cooling pad should pick up heat from the wheel by direct radiation and also from convection which takes place in the turbine-wheel spaces.

Heat transfer in the cooling pad is obtained through concentric fins which are machined in annular stock. The back side of this stock is machined for the water passages. This fin body is brazed to the annular ring which bolts to the turbine frame. A typical pad has nine cooling fins with the cooling water making 4 passes. Present plans call for circulating a total of 30 gpm through the pads with an expected 20 deg F temperature rise.

The Engineer as a Manager

(*Continued from page 302*)

experience we are gathering will soon permit us to appraise the effectiveness of these various devices for management training.

CONCLUSION

When we look back on the history of professions, we see that the rise of any true profession has heaped its bounty on humanity. Some of the more obvious instances have been truly dramatic. In our century the rise of the medical profession has greatly increased our span of life. The rise of the engineering profession has taken heavy burdens from the backs of men, and placed them on the backs of machines. The collective efforts of all professions have wiped out starvation, increased our standard of living, and have added much leisure time in which to enjoy that standard.

Yet there remain grave problems in the industrial society. Mysteriously ahead of us loom the depressions, the industrial struggles, and other ominous shapes. Our forebears must have regarded famine or pestilence with equal mystery and apprehension.

The challenge to the manager is to solve these problems of the industrial society. If he fail, he must make way for new leadership, as did the financier before him. If the manager succeed, he will have assured for himself a place of honor among the professions.

The engineer is possessed of an intimate knowledge of the machines of the industrial society. He is also possessed of a proved methodology for solving any problem in the sciences. This knowledge and this methodology can be of great aid to the select managerial circle. It behooves the engineer to supplement his engineering knowledge by such study as will enable him to compete successfully for a reasonable proportion of the managerial posts. Thereby, he will not merely satisfy his own aspirations; he will perform a vital and honorable public service.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

Compiled and Edited by J. J. Jaklitsch, Jr.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Hydrogen Bomb

SPECULATIONS on the possible reactions and mechanisms of a hydrogen bomb, according to *Chemical and Engineering News*, Feb. 13, 1950, have been many and varied with most involving the use of the existing atom bomb as a "trigger" mechanism to furnish the temperatures believed necessary to set off a hydrogen bomb. One suggestion is based on the work of Cockcroft and Walton, who, in 1932, bombarded lithium with protons and obtained some helium nuclei. This reaction would yield a maximum of about 2.5 times the energy of a uranium bomb on a weight-for-weight basis.

It is from this latter fact that estimates of the great power of a hydrogen bomb are drawn since atom for atom the fission of uranium or plutonium delivers 10 times the energy of any known fission reaction of the lighter particles. Also, the hydrogen bomb will not be subject to "critical size" limitations, but may be made as large as technical developments permit. However, if the efficiencies of the hydrogen-bomb reactions are of the order of those obtained in fission reactions, then the weight of the hydrogen bomb could easily exceed that which could be handled by present-day airplanes. Greater efficiencies would make possible the development of bombs of much greater destructive force than the present fission bombs. It is not at all clear what the cost is per unit of energy delivered of a hydrogen bomb versus a fission weapon, or whether the former will have any advantage over the latter in this important respect.

Another remote speculation is a bomb gaining most of its explosive energy from the fusion of two deuterons to form helium. Such a bomb would be able to deliver about seven times the energy of the present atomic bomb on a weight-for-weight basis. Astronomers have observed a somewhat similar reaction to take place in giant stars at a temperature of 15,000,000 C and approximately one atmosphere pressure as part of the carbon cycle. It is from this cycle that the sun gets its energy although higher pressures are at work. However, it is also noted that under these conditions it takes about 5,000,000 years for half of the hydrogen to react.

A bomb combining the deuteron-deuteron and lithium-proton reactions has also been suggested as a possibility. In this version, lithium deuteride (LiH^2) would be so placed as to surround a uranium or plutonium bomb which would trigger the entire reaction.

Issuance of the Seventh Semiannual Report of the Atomic Energy Commission, and the outline of the studies of Hydrogen 3 and Helium 3 in the report, may be an indication that at least the basic concepts necessary for the construction of a hydrogen bomb using tritium have been investigated.

According to the AEC report, Hydrogen 3 or "tritium," the artificial radioactive isotope of hydrogen, has an unstable nucleus which contains a proton and two neutrons. By the emission of a beta particle tritium decays into Helium 3, an isotope of helium with two protons and one neutron, which occurs in natural helium in the proportion of about one part in a million. When H 3 transforms itself into He 3, the changes that occur in such characteristics as the magnetism and spin of the three nucleons can be measured. In addition, there is special interest in He 3 because it is the only known stable atomic nucleus that contains more protons than neutrons. For these reasons and because of the relative simplicity of the nuclei, physicists and chemists have sought to produce H 3 and He 3 for use in research.

Important information has been gained at Argonne, Los Alamos, and other AEC laboratories, the report states. Studies are being made of interactions between protons, deuterons, tritons, helium 3 nuclei, and alpha particles (or, in other terms, nuclei of H 1, H 2, He 3, and He 4).

Deuterons are bombarded with tritons, and tritons with deuterons, to study reactions in which these two particles first combine then split into an alpha particle and a neutron. As the energies of the bombarding particles from a Cockcroft-Walton accelerator increase toward 100 thousand electron volts (100 Kev) the probability of the reactions occurring also increases (the triton's cross section for deuteron capture is higher). But when energies of the incident particles are raised still higher by using a Van de Graaff generator, the capture cross section falls off sharply.

In a series of experiments with a Van de Graaff generator, tritium was bombarded with high-energy protons. The scattering of protons by tritons at various angles and energies

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources, i.e.: (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

was measured to derive data fundamental to the understanding of nuclear forces. At higher particle energies, the reactions in which the proton is captured by the triton were studied. In one of these reactions the resulting combination became an "excited" alpha particle which converted itself to the stable state by emitting radiant energy in the form of 20-Mev gamma rays.

In a second reaction observed, the proton-and-triton combination split into a neutron and a nucleus of Helium 3. This latter reaction was of interest because it proved reversible, that is, Helium 3 bombarded with neutrons yielded protons and tritons.

"It was possible here," the report of the experiment states, "since good measurements existed on this reaction going in either direction, to verify a well-known theorem of statistical mechanics which relates the reaction probabilities of such a reversible system, this was the first time that an experimentally adequate check of the 'principle of detailed balance' had been made for a nuclear reaction."

These reactions permitted more accurate determination than ever before of the size of the mass difference between the neutron and the proton, and consequently of the mass of the neutron itself. Results obtained in other laboratories confirmed the findings and did away with previous discrepancies.

Radioisotopes for Industry

THE industrial employment of radioisotopes today ranges all the way from improving deicers for aircraft to the development of new catalysts for petroleum refining, according to a booklet "Radioisotopes—A Survey," published recently by the Kellex Corporation, New York, N. Y.

The survey points out that the role of sulphur in the mechanism of vulcanization has never been clearly understood, but by incorporating radiosulphur in the accelerators employed, certain process improvements have been made. Other experimental work has used radioiodine to determine what part silicones play in reducing adhesion of ice to rubberlike materials. It was this study which led to improved deicers for aircraft.

In the petroleum industry, radioisotopes are used for well logging and to tag and follow hydrocarbons through various processes. Tracer techniques have been used to study what goes on in the Fischer-Tropsch synthesis reaction for making synthetic gasoline from natural gas and coal; they have been brought to bear on such standard processes as isomerization and polymerization. Results to date are far from conclusive; however, accepted theory is being modified in the light of recent findings. The efficiency of adsorbents used to remove small concentrations of gases or liquids from a system has also been investigated. When the gas or liquid to be adsorbed is diluted with a known quantity of radioactive material, it is possible to make accurate determinations of the percentage removed by a given adsorbent. This is particularly valuable in the problem of removing toxic organic vapors and poisonous gases. Radioisotopes also permit analysis of the completeness of removal of an adsorbed material.

Industrial and automotive lubricants that show increased ability to prevent wear caused by friction of moving parts may result from another series of studies. Radioiron is being used to determine the physical changes that take place at a lubricated surface. When one bearing surface is plated with the radioisotope, the other later may be analyzed for transferred material. Also, analysis of the lubricant itself would be a method of determining when friction begins to cause wear. When bearings are made of alloys it is possible to employ radioisotopes of the elements to determine which component of the alloy is transferred by friction.

In the field of metallurgy, radioisotopes offer a direct means of improving the strength of materials, of producing alloys with greater resistance to corrosion, of improving manufacturing processes, and through autoradiographs, of determining inner structure without resorting to conventional x-raying procedure. Using alloys containing radioactive elements, studies have been made of self-diffusion in stressed metals, effects of diffusion coefficients on annealing and hardening, and surface versus volume diffusion. Another important study determined the amount and distribution of phosphorus in steel—invaluable because the amount of phosphorus required to make steel brittle is extremely small, and its detection a matter of accident prevention. A manufacturer of experimental alloys customarily adds radiotungsten to melts, later makes autoradiographs to study their internal structure as a more direct method than taking x-ray pictures.

Until recently, the report states, the supply of radioisotopes for industrial research and development has been limited. Further, although fairly complete information on the subject has been available, its dissemination has been slow. For these reasons, industry, generally, has been slow to appreciate the value of radioisotopes either as research tools or their possibilities as production-line devices. As production-line devices, radio material is used in several ways for purposes of instrumentation, and that such instruments prove far superior to conventional instruments has been demonstrated by at least one leading manufacturer. This manufacturer makes semitransparent material in a continuous sheet. To control thickness, the moving sheet passes through a slotted gage. Directly under the slot and beneath the moving sheet is a small amount of radiocarbon, which emits a weak stream of beta rays, electrons similar to those sent out from the filament of a radiovacuum tube. The stream of beta rays penetrates the sheet, the number actually getting through depending upon sheet thickness. Above the slot is an ionization chamber where the rays that do get through produce a weak electric current. Miniature vacuum tubes amplify this current, making it strong enough to operate an electric meter, which is graduated to read directly in units of sheet thickness.

Instruments of this general class, which depend upon sources of weak-energy beta emitters, are useful for measuring the thickness of soap films, rubber films, and thin plastic sheets. Extremely fine measurements have been claimed, in the case of the gage just described, to a hundred-thousandth of an inch. Glass plate, thick sheets of plastic or steel can be measured in the same way when more energetic beta and gamma emitters are employed. A refinement of the instrument, further amplification of the current, and connection of the Geiger circuit to the production machinery itself, would put the entire system under continuously regulated control.

A variation of the thickness gage has been suggested to measure density, since absorption of beta and gamma rays is also a function of density. A second technique for determining density has been worked out which depends upon reflection of gamma rays by the absorbing material. To put this fact into service it is only necessary to focus a source of gamma radiation on the wall of a pipe or vessel containing a solution whose density is to be controlled. The reflected rays are measured with a Geiger counter, accurate results being claimed for the method between 0.7 and 1.0 gram per ml in a 6¾-in-OD pipe with 0.3 in. wall thickness. In either density or thickness measurements, care must be taken to use a radioisotope of correct energy, and calibration is required for each material measured.

A very simple use of a radioisotope as a flowmeter has been made to measure the flow of condenser water. The radiomaterial is added to the stream at one point and the time re-

quired for it to reach a second point measured. The same method is applicable to measure the flow of any process stream.

Another simple and accurate device is a liquid-level indicator. By attaching a radioisotope to a float which rises and falls with liquid level, liquid depth may be read directly from a dial operated by a Geiger counter at the top of the tank.

Of potential value to soap and other cleaning-compound manufacturers are studies which have been undertaken to determine the role of various detergent constituents. Radiosulphur has been incorporated in a sulphosuccinic acid-type wetting agent to study the behavior of this compound as a surface active agent. The mechanism of flotation is also being investigated with recently synthesized radioactive long-chain aliphatic amines and acids. These studies will show which components of a detergent are most efficient with respect to flotation action, solvency, and adsorption, and should eventually result in improved manufactured products.

Another instrument application is a universal switch, operated by the ionization of a gas acted upon by a source of radiation. The principle upon which it is based is movement of the source toward and away from a gas-filled space, alternately making the gas a conductor and a nonconductor.

While directed primarily at the industrial reader, the publication includes work in the life sciences. A limited supply of booklets is available from Kellex Corporation, 233 Broadway, New York, N. Y.

Underground Hydro Plants

A CRITICAL review of 60 underground hydroelectric plants which have been built or are being built in the world and which have a combined installed capacity of more than 7,000,000 hp, was given by Joseph D. Lewin, Board of Water Supply engineer of New York, N. Y., at the 1950 annual meeting of the American Society of Civil Engineers. He pointed out that since the Buchbergmuehl plant in Germany was placed in operation in 1907, the rapid development of subterranean powerhouses all over the world seems to indicate not only their basic economic feasibility but their operational advantages.

According to Mr. Lewin, there are neither geographic, climatic, nor topographic limitations on the use of underground power plants. From above the Arctic Circle, where the Swedish Porjus and Harspranget plants and the Russian Niva plant have been built, to southern Italy, where the Flumendosa plant is situated; from the Sulak in the eastern Caucasus to the Brommat and Baton plants in France, underground plants spot the globe. Even south of the equator, in Peru and Australia, there are such developments. Underground power plants have been built at all elevations, from 7000 ft above sea level to the Niva plant just south of Murmansk, which discharges below sea level into Kandalaska Bay. The units range from a 31-hp unit in Friedigen, Germany, to a 2,800,000-kw development on the Snowy River in Australia.

Neither are underground power plants affected by considerations of hydrostatic head. They range from the 17.7-ft head plant at Friedigen to the 3540-ft-head development at Tvin in Norway. Water quantities vary from 15 cfs at Foce Ponale, in Italy, to the 14,200-cfs plant at Harspranget in Sweden.

These plants are built in all types of rock, igneous, sedimentary, and metamorphic. Some are built in excellent, hard, sound rocks like granites of Sweden, requiring practically no support, a few have been built in badly fissured, even disintegrated rocks, which required substantial and nearly continuous roof supports.

From the operational point of view, there are run-of-the-river plants and storage-fed plants; base-load and peak-load plants. There are even two pumped storage plants—the Swiss Palue and the Italian Coghinas. No matter how different these plants are in regard to size, location, layout, and operation, they have one thing in common. They represent the most economical solution for the development of power resources at the particular site.

Although underground hydro plants are more immune to aerial bombardment than surface plants, this consideration was not given much importance, since the majority of them were constructed before strategic bombing was developed during the last war. The original decision to place plants underground was primarily an economic one. An analysis shows that costs are as much as 40 per cent less than conventional surface developments, most of the savings being due to shorter developments, elimination of penstocks and valves, and savings in tunnel linings. Rock is utilized as a structural material and made to carry loads. Underground developments require less operating expense; there is no painting, no roofing, no heating, and only a small depreciation charge. The cost of excavation is 90 per cent of the investment. Underground powerhouses are adapted to architectural treatment. The domed structures are suited to indirect lighting and air conditioning.

The seemingly paradoxical fact that the underground developments are cheaper than surface developments can be attributed to more economical methods of excavating rock in Europe. Based on prevailing American labor costs, European tunneling methods can reduce the cost of rock excavation by as much as 60 per cent, Mr. Lewin stated.

By using light, high-speed drills which weigh 35 to 55 lb each, and special drill steel, light drilling platforms and fewer men are required. Also less air—1000 cfm per drill—is needed. Holes are smaller ($1^{5}/_{16}$ in. diam), are close together, and the charge in each hole being smaller, the overbreakage is less and the roof supports lighter. Drill steel is tipped with a nondetachable tungsten-carbide chisel-shaped bit that can be sharpened only by grinding. It is claimed that a bit can drill 70 ft in hard granite before regrinding. An 18-ft hole can be drilled at a rate of 1 fpm with one change of steel. The machine automatically drills a set number of feet, stops drilling, washes out the hole, retracts the drill steel, and stops. One driller can operate two or more machines.

A new development in lining circular pressure tunnels is the use of prestressed concrete. The lining consists of precast blocks $1^{1}/_{2}$ to 4 in. thick, placed in the tunnel to form a full ring, which is then prestressed by high-tensile-strength steel loops or by high-pressure grouting in the space between the rock and the ring. The concrete is prestressed to a compression 50 per cent higher than the expected tensile stress. The blocks may also be treated with asphalt to improve their watertightness and to reduce friction losses. The thin prestressed linings reduce the required excavation and contribute toward further savings.

Electronic Printing Presses

A PREDICTION that the electronic motor drive gives definite promise of being the printing-press drive of the future was made during the annual winter meeting of the American Institute of Electrical Engineers at the Hotel Statler, New York, N. Y., by J. A. Johnson, chief electrician, Times-Mirror Company, Los Angeles, Calif., and E. M. Stacey of the General Electric Company. The authors jointly concluded that printing presses are a sound field for application of electronic motor drives.

According to the paper the old conventional press drive suffers from certain inherent drawbacks which the new elec-

tronic printing-press drive would eliminate. These current technical problems include such items as a need for an extra threading motor, with necessary reduction gearing and overrunning clutch, drop-off of efficiency of a wound-rotor motor with speed, and speed regulation gets progressively worse as speed is reduced.

In the new electronic drive the following economic advantages should be considered, the authors said:

1 Although the first cost of a complete electronic press drive is usually higher than a-c wound-rotor drive, the savings in power costs, maintenance costs, and installation costs tend to more than make up the difference.

2 Power savings result from a higher efficiency of electronic drive at reduced speeds and this is often a material annual saving.

3 Installation costs are reduced to a minimum by virtue of factory-assembled and wired cubicles which need only be bolted down and interconnected.

4 Since no major power is dissipated in the control room, special ventilation is not required. A savings of $15,000 on air-conditioning equipment alone was estimated by the consulting engineers on a recent large installation.

5 There is the absence of power contact making or breaking devices such as contactors or power rheostats.

Enlarging upon the new electronic drive, the authors pointed out the following:

1 Jogging and threading, as well as high-speed operations, are accomplished by the main motors and an extra motor is not needed.

2 Over-all efficiency of the system stays at a high value over the full production range, and speed and acceleration rate are not materially affected by load changes.

3 Acceleration from threading speed to full speed can be accomplished in 35 sec and decelerated at the same rate.

4 Conventional dynamic braking can be set to give any desired rate of stopping.

5 As many as nine 40-hp motors are mechanically coupled to operate in parallel to drive large press combinations.

6 A motor is furnished for each press unit, so as units are added or subtracted the per cent loading on each of the motors in use remains constant.

In summarizing, the authors stated that at the present time large electronic-press drive installations are operating in four metropolitan newspaper plants in this country and equipment for four more publishers is now in the process of manufacture or installation.

They said that, functionally, electronic drive is superior to any conventional drive. Reliability is equal or superior to that of any other type of drive. Economically, electronic drive can be justified in the majority of metropolitan installations, and, as advances continue to be made, will certainly become more and more adaptable to smaller installations.

Second-Sound Velocity

THE velocity of second sound at temperatures well within one degree of absolute zero has been measured successfully, for the first time, in recent low-temperature tests conducted by the National Bureau of Standards, Washington, D. C. Study of second sound, the unique wavelike process of heat transfer occurring only in Helium 2, offers a most sensitive means for investigating the unusual properties of this substance at very low temperatures—properties which in many ways seem to constitute a fourth state of matter. Thus the results obtained

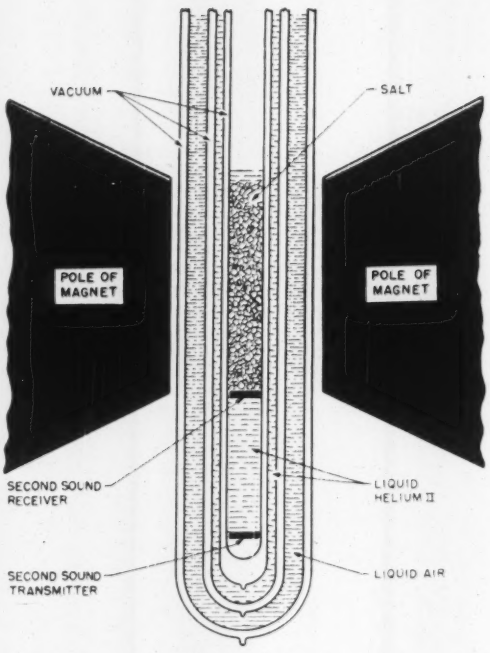


FIG. 1 DIAGRAM OF APPARATUS DESIGNED TO MEASURE THE VELOCITY OF SECOND SOUND AT TEMPERATURES NEAR ABSOLUTE ZERO

at the Bureau, in addition to settling a point of long-standing disagreement among low-temperature physicists, provide a useful orientation for mapping future research efforts in this field and should eventually lead to a better understanding of the nature of matter.

In order to carry forward the present theory of the nature of He 2 near absolute zero, it was necessary to make a choice between the assumptions of L. Landau and those of L. Tisza. The Bureau therefore undertook a laboratory study of the velocity of second sound below 1 K. The resulting data provide a clear-cut decision in favor of Landau's hypothesis of energy partition.

The Bureau's investigation of second-sound velocity employs a recently developed pulse method so that signals which would otherwise be quite difficult to detect are presented on an oscilloscope screen for visual observation. Pulses or bursts of heat, generated electrically within liquid He 2, travel through the helium and are detected upon arrival at a temperature-sensitive element; meanwhile, their transit time is measured accurately by electronic timing circuits.

Cooling below 1 K is achieved by the method of adiabatic demagnetization, in which crystals of a paramagnetic salt immersed in a part of the He 2 are carried through a special magnetizing and demagnetizing cycle. Alignment of the ionic dipoles during magnetization produces a temporary heating which is soon (within perhaps three minutes) offset by concurrent helium evaporation. Subsequent demagnetization releases the dipole alignment, and a sharp temperature drop occurs within the crystals. Because of the remarkable speed with which heat is transferred in He 2, this cooling is rapidly transmitted to

the adjacent liquid helium and in turn to the portion of the He 2 which surrounds the equipment for measurement of second-sound velocity.

To reduce heat exchange with the surroundings, the paramagnetic salt (iron ammonium alum) and the apparatus for transmitting and receiving second sound are mounted within the innermost of three concentric Dewar flasks. The outermost Dewar contains liquid air while the intermediate and innermost vessels contain liquid He 2. The innermost chamber is suspended in a vacuum by a narrow glass capillary, which provides the only heat path from the outside. This Dewar system is mounted on a movable carriage so that the salt crystals can be centered between the poles of a powerful water-cooled electromagnet; at other times the Dewars can be slid to an outer position for receiving liquid helium from a portable liquefier.

By pumping off helium vapor through a vacuum connection, the temperature of the intermediate Dewar is lowered to about 1.4 K. The temperature of the liquid He 2 in the innermost Dewar may then be brought down to about 1.1 K by pumping through the capillary suspension. At this point a magnetic field of about 12,000 oersteds is produced across the poles of the electromagnet, magnetizing and heating the paramagnetic salt. However, the heat thus produced is almost immediately lost from the inner chamber by evaporation of liquid helium and removal of the helium vapor through the vacuum connection. The magnetic field is then removed, and the resulting demagnetization of the salt causes the temperature of the crystals to fall rapidly.

Use of the pulse method to measure second-sound velocity provides an instantaneously indicating direct-reading technique which avoids the difficulties inherent in the relatively slow and heat-producing standing-wave method used by Peshkov in his original observation of second sound. Disk-shaped heat pulses of about 100 microseconds' duration are generated electrically at the second-sound transmitter, which consists essentially of a disk-shaped electrical resistor a few inches below the paramagnetic crystals. These pulses travel upward through the He 2 at their characteristic wave velocities to register on the receiving element about two inches above. The receiver is a temperature-sensitive resistor made of a thin disk-shaped carbon layer and carrying a small steady current. Upon arrival at the receiver, each pulse of second sound produces a small voltage pulse which is amplified and presented on vertical plates of an oscilloscope. As the horizontal time sweep of the oscilloscope is triggered at the start of the initial transmitter pulse, the horizontal position of the signal is a direct indication of wave velocity.

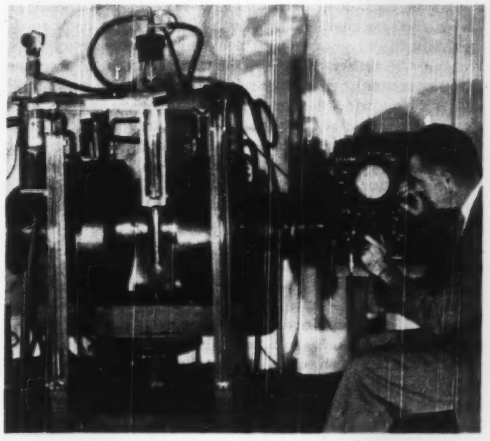


FIG. 2 APPARATUS USED FOR MEASURING VELOCITY OF SECOND SOUND

(By means of a special technique, pulses of second sound are presented on the oscilloscope screen (*right*). Cooling below 1 K is obtained by the method of adiabatic demagnetization. Crystals of a paramagnetic salt are immersed in liquid He 2 within the inner of three coaxial Dewar flasks supported between the poles of a large water-cooled electromagnet (*left*).)

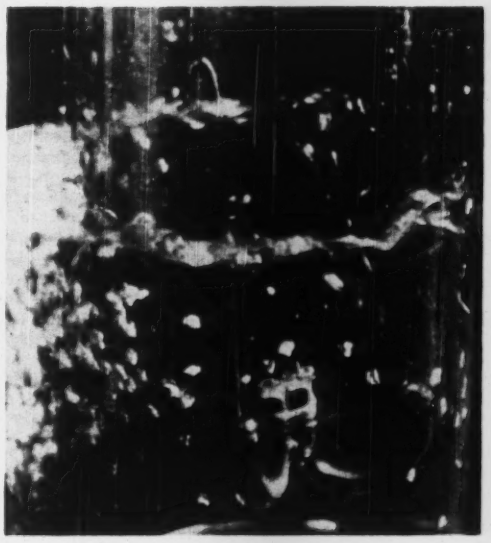


FIG. 3 UNRETOUCHED PHOTOGRAPH MADE AT THE NATIONAL BUREAU OF STANDARDS ILLUSTRATES THE FOUNTAIN EFFECT OF LIQUID HELIUM

(This is one of the few successful photographs ever taken of this phenomenon, which shows how the direction of flow of Helium 2 may be controlled by heating or cooling. A J-shaped glass tube has been suspended in a quantity of liquid Helium 2 surrounded by liquid air in an outer flask. The glass tube projects out of the helium and is approximately level with the liquid-air surface. One section of the wider part of the tube contains emery powder. When the liquid helium in the lower part of the tube is warmed by exposure to light, helium spurts through the emery powder and out the top of the tube in a spectacular fountain, just left of the rod at top. This effect is caused by the inherent tendency of the atoms of the superfluid to migrate toward a point at which heat is applied. The atoms of the normal fluid which would ordinarily travel in the opposite direction, cannot pass through openings less than $^{1}/_{100,000}$ in. in diam. The end result is to build up a pressure on the colder side of the powder, resulting in the fountain effect.)

In the demagnetization experiment performed at the Bureau, not only was an unmistakable increase in velocity observed below 1 K, but the value nearly doubled, rising smoothly from the minimum of 18.4 meters per sec at 1.1 K to 33.9 meters per sec at a temperature estimated to lie somewhere between 0.5 and 0.7 K. By reducing heat leaks and introducing other refinements, extension of the observations down to 0.1 K appears feasible.

The Bureau's investigation should renew interest in the possibilities of new methods for producing extremely low tem-

peratures. When liquid helium passes through a small opening, 3 microns or less in diameter, atoms of the normal fluid are left behind. Since the superfluid atoms passing through the orifice do not take any thermal energy with them, the temperature on one side of the opening is considerably reduced. It should thus be possible to obtain a substantial reduction in temperature by repeatedly passing He 2 through small openings.

Steam and Gas Turbines

THE January, 1950, issue of the *Westinghouse Engineer*, covers a mid-century review of important engineering events in which the Westinghouse Electric Corporation has participated during the past fifty years, and a forecast of what may be in the future. Of special interest to mechanical engineers, it is felt, are the two articles on central-station steam-power generation and gas turbines by D. W. R. Morgan, Mem. ASME, vice-president in charge of the steam and aviation gas-turbine division of Westinghouse. Brief versions of Mr. Morgan's articles follow.

Central-Station Steam-Power Generation

The first steam turbine for central-station use began operation early in 1900 in the plant of the Hartford Electric Light Company. It was a 2000-kw, 1200-rpm condensing turbine, far exceeding in capacity any unit previously built. Now, 50 years later, the modern high-speed machines currently going into service have 50 times this capacity, and larger slower machines have been running for many years.

The "front line" in a steam turbine is the blading. In a sense all other components of a turbine are merely necessary auxiliaries that enable the blades to do their work. Modern blades have, by a long evolution, come to be beautifully finished precision parts, highly efficient for the job to be done. They are the result of the combined intensive efforts for many years of metallurgists, fluid-flow specialists, and mechanical engineers. That evolution has been in several directions: the metal used, blade shapes, and methods of fastening or roots.

Credit for the tremendous growth of turbine capacities, speeds, and adaptability to service with elevated steam pressure and temperature is in part due to significant progress by the steel industry and to a broad field of metallurgical development.

Many other developments have led to the steam turbine of 1950. Nearly all central-station turbines operate condensing, that is, exhaust at a pressure far below atmospheric into condensers, from which feedwater of good quality is returned to the boiler plant. Most modern units operate at 3600 rpm, driving two-pole 60-cycle generators which have increased sixfold in maximum rating in two decades.

Now under construction is a single-shaft 3600-rpm turbine for 125,000 kw maximum output with triple-flow, low-pressure section. A triple-exhaust turbine of this general type can be made to deliver 150,000 kw economically at 28.5 in. vacuum. The relatively few units built for ratings above the economical limit of the single-shaft 3600-rpm are either tandem-compound 1800-rpm machines, or cross-compound.

Single-case, high-speed units are available up to 30,000 kw inclusive, and will eventually be extended further. The tandem-compound construction extends upward to include 125,000 kw. The more common steam conditions encountered for units of 20,000-kw rating and upward are 850 lb pressure, 900 F, but 1250 lb, 950 F, and 1450 lb at 1000 F are growing in favor.

The problems associated with these top steam conditions are both metallurgical and mechanical. When temperature reaches 1000 F the steam chest is separated from the turbine case. This gives a simpler more symmetrical casing. By suitable selection of materials this construction has proved satisfactory in service at 1050 F.

The pattern in the next several years for the large turbine is rather well established. The step to 1050 F steam has only recently been taken. It will be well to "digest" this before moving upward. Caution will be exercised as a prolonged outage of costly revenue-producing machinery would rapidly devour the savings otherwise effected. Laws of diminishing returns prevail. It is therefore reasonable to expect that while operating experience is being gathered with the pioneering 1050-F plants, new installations, generally, will be built for temperatures closely approaching such level. Thus the average of the nation's power plants will rise closer to this present top limit.

After some pause at the 1050 F level, the economics of rising fuel and labor costs will bring to being a large 1100 F turbine. This should be possible with modification in construction and materials of the general type now in use. Perhaps the next step to 1150 F will soon follow, but this would require better materials than are now at hand.

Machines of larger maximum capacity are clearly in the short-range picture. These do not appear illogical or impossible if the economic need for larger machines arises.

Some systems are now approaching 2 million kw in capacity and could justify the largest turbine-generators now available. Therefore, in the not-too-distant future, turbine-generators of 150,000 to 200,000 kw are likely to be in demand. Already under construction are single-shaft 3600-rpm turbines having maximum capabilities of 125,000 kw. Application studies are being made for larger machines, which should result in a few years in a single-shaft turbine capable of delivering 150,000 kw. Because an 1800-rpm turbine can be built about four times larger in output than 3600-rpm units, single-shaft low-speed machines of 600,000 kw would be technically possible. However, using known designs, materials, and near-future steam conditions, turbines larger than 150,000 kw would be cross-compounded to obtain the advantages for the high steam conditions of 3600 rpm and the ability of the 1800-rpm construction to accommodate the accompanying tremendous exhaust-steam volume.

The reheat principle has reappeared and gives every evidence that it will prove satisfactory. A single stage of reheat to the initial throttle temperature decreases heat consumption by about 4½ per cent.

Turbine standardization has been both successful and popular. It has released design engineers for more development work, thus disproving the argument that standardization restricts progress. In the four years this program has been in effect, about 60 per cent of the units built by Westinghouse within the range of standardization were of such class.

The top limit of standards—60,000 kw—is small for the larger systems. In the light of recent developments standardization of a 90,000-kw machine is indicated and preliminary consideration might be given to one of 135,000 kw.

United States population and kilowatt consumption are both growing steadily and show every indication of continuing to do so. Within the next ten or twelve years installed generating capacity will be doubled; within the remainder of the century at least tripled or quadrupled. We can hardly expect that the resulting gigantic power systems will be served simply by large numbers of big generating units of the kind already visible on the horizon. What they will be cannot be predicted with finality, because of enormous intervening obstacles. But suppose that intensive research provides suitable materials and that the economic situation becomes such as to justify

ultimate thermal efficiency regardless of machine cost. What form might the turbine colossus take and what would it achieve by today's standards? A turbine built for steam conditions of 1200 F and 3206 lb pressure (which is the pressure at which water and steam have the same density) should produce about 8 per cent more kwhr per ton of coal than a 1050 F, 2000-lb turbine, both employing reheat. This would result in a turbine with about 40 per cent thermal efficiency compared with today's anticipated best of about 37 per cent.

In building such a superturbine the front end would be the critical one. Steam might be brought to the first-stage wheels through a series of small inlet pipes feeding nozzle chambers separately cast of some metal unknown at present, capable of withstanding such high pressure at high temperature. Forged parts would be out of the question because operating temperatures are already on the heels of forging temperatures. The rotating element would pose severe problems because of the high centrifugal forces also at high temperatures. Approaches to this matter might take different directions. Instead of one large rotating first stage there might be several small wheels operating in parallel at speeds two or three times 3600 rpm and geared to the main high-pressure element. These small wheels, using alloys developed for gas turbines or some improved austenitic material, could expand the steam from the 3200-lb level down to 1800 or even lower where it could be handled more conveniently.

An alternate method would be to build high-pressure-turbine stages in a separate compact turbine element directly coupled in tandem to the main unit shaft.

For the 3200-lb turbine to retain the mass-flow relations of the high-pressure stages, the rating should be at least 240,000 kw, possibly more. This is desirable from the standpoint of leakage control and good experience.

The exhaust end would not likely interfere with building a 240,000-kw unit even at 3600 rpm for these extremes of 1200 F, 3200 lb. Existing exhaust blades arranged for quadruple flow would handle the steam for a 240,000-kw turbine at the supposed inlet conditions. Furthermore, we can ultimately look for exhaust blades even longer than the present 23 in. Assuming that such a longer blade provides a 25 per cent increase in exhaust annulus, a high-speed turbine with quadruple exhaust flow could then be built for a maximum output of 300,000 kw.

If turbines larger than 300,000 kw become economically justifiable, the most obvious way of obtaining both sufficient exhaust annulus and generator capacity is to go to cross-compounding with an 1800-rpm low-pressure element, whereupon a turbine delivering 500,000 kw would become possible. Conceivably, then, such a gigantic unit for 1200 F, 3200 lb, might be a cross-compound machine with multiple flow, low-pressure section, and a high-pressure element of the multicylinder type, with the first stage in tandem or geared to this 3600-rpm element.

The Gas Turbine

The first jet engine of American design, the Westinghouse 19-A, was brought to test (March, 1943) in the brief time of 15 months after a start was authorized. It was a radically different type of power plant and involved temperatures several hundred degrees beyond those accustomed for steam apparatus. Unlike most jet-propulsion engines developed by the Allies at this time, this one consisted of a compressor of axial-flow form (in distinction to the radial or centrifugal-flow type), a combustion chamber, and a turbine in a straight line, resulting in a compact streamlined arrangement.

Although many improvements of detail and in performance have since been made, this construction has remained and, in fact, has become the pattern for jet units the world over. Interesting features of the 19-A engine included an adjustable exhaust nozzle, a combined oil cooler and reservoir, and a combustion chamber made up of 24 separate burner cells.

Two other types of jet engines were also developed. One was a small engine (type 9-A and 9-B)—9½ in. in diam—produced in limited numbers. The first of these weighed only 150 lb and developed 275 lb thrust. A gas turbine (25-D) was designed and a gear built for propeller drive.

Various members of this jet-engine family have powered many illustrious military planes such as the McDonnell FH-1 "Phantom" and F2H "Banshee," the Chance-Vought F6U "Pirate" and its F7U "Cutlass," and the Douglas XF-3-D "Sky Knight," all-weather fighter. Newer applications are the Lockheed XF-90, the McDonnell XF-88 Air Force Fighter, and the XJ-85 McDonnell Parasite Fighter. Experimental planes to explore transonic flight include the Douglas D-558-2 "Skyrocket" and the Northrup XS-4.

Eight years have brought improvements at a fast pace in jet-engine construction—without altering the basic principle. Research on materials, involving creep to rupture as well as fatigue testing, has produced no less than four turbine-blade materials, each better than its predecessor, and each finding its way into production engines. Precision-casting techniques have been developed and applied to production of turbine blades. New research-developed high-temperature alloys such as K-42-B, Refractaloy, and Discaloy, found application in the hot parts of the engines. The cell-type combustor of the 19A gave way to the annular or basket type of burner chamber which, further perfected, remains the accepted type. By virtue of these developments the altitude of reliable combustor operation has been increased fourfold. Burner life has been improved by nearly 20 times, and is now comparable to that of other basic engine parts. Roller bearings, superior in cold weather, have replaced sleeve bearings.

Present-day jet engines can perform under operating conditions that were not visualized when the first designs were achieved. Increased emphasis is given to operation in very cold and in very hot weather. The icing problem of the engine itself is recognized and anti-icing means are being developed.

Increasing requirements, primarily for improved performance, will tend to make the jet engine more complex. Further refinements and increased compression ratios may well bring down the fuel consumption to 0.7 lb of fuel per lb thrust within the next decade, an improvement of 50 per cent since 1941. Very likely jet engines will divide into two classes. One, for long-range and transport, to be highly efficient, with long life, relatively heavy and complex. The other, for extremely high speed, moderately efficient, and designed for the intake pressures and temperatures suitable for supersonic speeds.

The rapid progress with jet units for aircraft as a natural consequence spurred development of gas turbines for land use. At Westinghouse this led, in 1946, to the completion and testing of a 2000-hp 1350-F gas-turbine power plant created for possible use either as a locomotive unit or for industrial service. This unit, like its older cousin in aircraft duty, consisted of an in-line arrangement of air intake, axial-flow compressor, tubular-type combustor, and turbine. With it on the same bedplate are a gear and two d-c generators. The whole occupies a space but 20 ft long, 4½ ft high, and 5 ft wide, and weighs 26,000 lb—only about one tenth as much as a comparable, well-perfected, Diesel-electric power plant.

This unit was placed in experimental service in mid-1949 in Arkansas, driving a centrifugal compressor in a natural-gas pipe line.

The gratifying results of the shop test on the 2000-hp experimental unit resulted in the decision to construct two additional

similar units for installation in a locomotive now virtually completed. A still larger industrial type of gas-turbine power plant is in the design stage and a large, closed-cycle, highly efficient type of gas turbine is being manufactured. Also, a gas turbine has been built for operation with combustors and compressors of the free-piston type, and a 3000-hp unit for similar service is being manufactured.

The task with the gas turbine in the immediate future is, clearly, to develop it for long-continued operation with gas temperatures beyond 1300 F, and to obtain information as quickly as possible that will lead to constructions suitable for temperatures up to 1500 F. Such programs are being aggressively pursued.

Both the central-station field and industry have, generally, several attractive applications for the gas turbine that await its development. There is little doubt that such practical long-life machines will become reality and that machines of open-cycle form, and in capacities up to about 10,000 kw, will be built in a few years. Closed cycles offer possibilities of machines several times this rating.

Diesel Engines

THE growth of the Diesel industry has been phenomenal since the turn of the century, it is pointed out in a new booklet published by the Sinclair Refinery Company, entitled "Diesel Engines Fuels and Lubricants." For example, in 1902, only four years after its introduction in the United States, the first Diesel municipal light plant was constructed. Expansion was restricted until 1912 when the original Diesel patents expired and the ideas became public property. Thereafter, expansion and progress were accelerated and production increased from a figure of 10,000 hp to 50,000 hp in 1915. Ten years later, in 1925, Diesel-engine production in the United States exceeded 400,000 hp and a temporary peak was reached in 1929 when the annual production approached 500,000 hp. During the next four-year period, production slumped from the 1929 high to approximately 140,000 hp in 1933 which represented the total output from some 48 engine manufacturers. This figure was lower than the annual production in 1919.

During this total 31-year span, new applications of the engine in industry were introduced which included the following:

1 Two large Diesel engines for marine service in this country were built for the U. S. Navy in 1914, and by 1917 additional American designed Diesels were going into marine service.

2 In 1920 solid injection of fuel oil was introduced to effect simplicity in production and improve fuel economy.

3 The first Diesel-electric locomotive was introduced in 1924, and in 1925 the first Diesel-powered locomotive was placed into railroad switching service.

4 Diesel-powered trucks and automobiles appeared in 1930.

5 The first Diesel tractors were introduced in 1931.

6 In 1932 the first Diesel-powered bus was placed into service and there were approximately 1000 municipalities utilizing Diesel-powered generating plants.

7 In 1934 the first high-speed main-line Diesel passenger, streamlined locomotive established a speed record.

The recovery from the slump which had its low in 1933 was rapid, and in 1935 the total Diesel production was 532,000 hp. This jumped to 1,321,000 hp in 1937 and an indication of the prominent role which Diesels were to assume in World War II were manifested in the 1940 production which reached 3,250,000 hp.

In 1944 Diesel-engine production reached an all-time peak with a total of approximately 35,000,000 hp and more Diesel engines were produced in this one year than in all the previous years from the construction of the first Diesel in 1902 until October, 1942.

It is interesting to note that the total Diesel horsepower installed in the United States increased from a figure of 5,500,000 in 1935 to 45,000,000 at the end of 1945. The trend throughout this period had been toward the development of lighter-weight medium- and high-speed engines with applications in all fields of industrial and marine power. The advent of World War II accelerated development and production such that the total war output reached 113,980,000 hp. While the largest percentage of this horsepower went into marine installations, a substantial portion was used for portable power plants, tanks, tractors, locomotives, and other related equipment. Today the railroads, buses, construction equipment, and trucks are absorbing a substantial number of engines.

Early engines weighed as much as 400 lb per hp in contrast to present high-speed automotive Diesels which weigh less than 10 lb per hp. Larger modern medium- and slow-speed Diesels for stationary and marine installations are available at weights varying upward from 20 lb per hp.

Postwar demand for Diesel power had exceeded all expectations, and predictions by various authorities indicate that in excess of 100,000,000 Diesel hp will be manufactured within the next ten years. This demand is not confined to any one industrial field, although the volume of Diesel horsepower being channeled to the railroads for Diesel locomotives exceeds all other industrial applications.

In the field of rail transportation a number of the Class I railroads have embarked on a long-range Dieselization program where eventually all steam-locomotive power for switching, passenger, and freight service will be replaced by the Diesel counterpart. Current production records indicate that virtually only Diesel locomotives are being manufactured. Advantages favoring the Diesel in locomotives are higher availability, lower operating cost, higher sustained speeds, together with reduction in track maintenance, and lower over-all maintenance cost.

Expansion in Dieselization of city, cross-country, and transcontinental buses continues at a high level on a national basis. Here again, the advantages are low over-all operation and maintenance expense coupled with greater flexibility.

Diesels are also being used in increasing numbers in trucks for both over the road and certain short-haul operations. The advantages are in the operating economy resulting from higher efficiency over the entire range of speed and load; and particularly under part-load operations. Another advantage is the improved throttle response due to the absence of manifold lag. This factor is important to the trucking operator because it means less gear shifting than is required for a gasoline-engined truck, especially under slowing-up conditions on heavy grades.

In the tractor and construction-machinery fields, the Diesel has been proved the leader and remains unchallenged for reliability and economy under all types of load and service operating conditions. It is anticipated that future farm and agricultural implements will be Diesel-powered to a much greater extent than currently is the case.

The number of Diesel-powered stationary generating plants have also shown an increase in the postwar period and future electric-power requirements of communities and rural areas for such public utilities indicate expansion for the future.

For marine power, both propulsion and auxiliary units, the Diesel has proved outstanding. Installations of Diesels have been made in all types of surface craft from small pleasure boats, commercial tugs, and dredges to large freighters and modern luxurious ocean-going passenger ships. Dieselization of marine equipment which was accelerated by installations in various surface craft and submarines for Naval operations in the

last war is expected to continue to increase for peacetime commercial operations. Of interest, as an indication of expansion on inland waterways in this country, are statistics which reveal that of vessels of 100 hp or over, 65 per cent are equipped with Diesel engines, and new construction is almost exclusively Diesel.

Other fields in which the Diesel engine has found wide application and in which continued expansion may be expected are as follows: Power and light packaged generating sets, water pumping plants, oil-well drilling and pipe-line pumping installations, mining operations, shovels, logging operations lumber mills, and air compressors.

Photomicrometer

IN a crystalline material such as metal, the interatomic spacing is altered by the application of an external stress. Since this spacing can be measured by x-ray-diffraction techniques, it is possible to determine the magnitude of the lattice strain. In connection with investigations in the field of x-ray-strain measurements, John A. Bennett of the National Bureau of Standards has developed a "photomicrometer" which is reported to have several advantages in measuring diffraction patterns. This work represents an extension of a previous development by the Bureau's Metallurgy Division of a more sensitive x-ray-diffraction technique for the determination of strain in metals.

The primary difficulty encountered in the x-ray measurement of stress or strain in metals is the lack of sensitivity. This is due to the small change in diameter of the diffraction ring with change in stress and the diffuse nature of the ring, which makes precise measurement of its diameter difficult. The principal requirement of an instrument for measuring the diffraction rings is therefore a high degree of accuracy. The Knorr-Albers microphotometer used in previously reported work was excellent in this regard. However, it has two disadvantages. First, its chart record is jagged, making it difficult to locate the maximum; and second, the time required to obtain measurements is excessive.

In order to eliminate these disadvantages without decreasing the accuracy obtained on the microphotometer, the new instrument was designed for measuring the patterns directly. The calibrating ring of known inside diameter is recorded on the film immediately after the diffraction ring, and the radius of the diffraction ring is determined by measuring its distance from the inside of the calibrating ring.

The apparatus is essentially a densitometer with a dial indicator to measure movement of the film. A novel feature is a curved slit in the optical system so arranged that the light beam which scans the diffraction ring is an arc having the same radius of curvature as the ring. In this way the entire ring over an arc length of 15 deg is automatically integrated to determine the point of maximum density.

After passing through the film, the light is received on a barrier-layer-type photocell. This is connected in a compensating circuit with a galvanometer and a second cell illuminated by direct light from the source. Thus fluctuation in the galvanometer reading due to changes in intensity of the source are eliminated. A fairly sharp maximum in the galvanometer reading is observed when the diffraction ring on a typical pattern is scanned, so that the results can be reproduced within 0.01 to 0.02 mm.

In operation the film carriage is moved until the maximum density of the diffraction ring is located, and the reading of the dial indicator recorded. The carriage is then shifted until the light beam is positioned on the inside edge of the calibrating ring; the indicator reading is again noted. The difference between these readings and the known radius of the calibrating ring gives the radius of the diffraction ring.

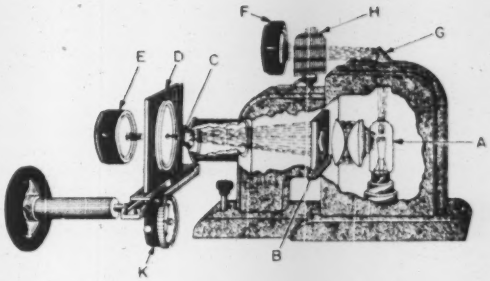


FIG. 4 SCHEMATIC DIAGRAM SHOWING THE OPERATION OF THE PHOTOMICROMETER

[Light from the source (A) is focused by condenser lenses onto a curved slit (B). The image of the slit, reduced 5 to 1 by the 24-mm microscope objective (C) is focused on the film in the holder (D), and the light which passes through the film is measured by photocell (E). Variations in the intensity of the source are compensated by cell (F) which receives its light through a prism (G) and adjusting screen (H). Movement of the film holder is measured by the dial indicator (K).]

A comparison of measurements from the Bureau's instrument with those obtained from conventional microphotometer records showed both results to be nearly identical in actual magnitude of the average pattern radius as well as in precision (as indicated by the scatter of individual readings). Use of the new instrument over a several-month's period has saved about 25 per cent of the total time or 15 to 20 per pattern, it was estimated.

Aluminum Industry

THE addition of aluminum by the Government during the latter months of 1949, to the list of strategic metals to be stockpiled, was one of the significant developments in the aluminum industry during the year, The Aluminum Association reported. No direct purchases of aluminum during the current fiscal year are contemplated, however, the report added, as requirements are expected to be met with deliveries from the General Services Administration. Bauxite, the principal ore from which aluminum is produced, has been on the stockpile list for some time and will remain so.

The droughts that plagued large portions of the United States during 1949 affected the aluminum industry in two ways, the report says. First, the resulting low-water conditions at some hydroelectric plants furnishing power for producing aluminum curtailed production of primary metal during certain portions of the year. Second, the need for irrigation in agricultural areas showed a marked increase, and the use of portable irrigation systems made with aluminum pipe and fittings saved many crops that otherwise would have been either partial or complete losses.

There was considerable plant construction and modernization during the year, it was reported. The new reduction plant under construction by Aluminum Company of America at Point Comfort, Texas, is practically completed and will soon be in production. The same company shut down and dismantled its obsolete Niagara Falls plant which was built in 1907. Two idle pot lines were put in production at the Jones Mills, Ark., plant of the Reynolds Metals Company. The aluminum di-

vision of the Vanadium Corporation of America established a new aluminum-alloy plant at Chester, Pa.

Aluminum Company of American also completed and placed in operation its new rolling mill at Davenport, Iowa. This mill is notable not only for producing aluminum sheet and plate that is wider and longer than was heretofore rolled in the United States, but also for the extent to which aluminum was used in the construction of the buildings. The Kaiser Aluminum and Chemical Corporation purchased from the government three plants which it had been operating on a rental basis. During the year, that company began the production of foil at its Permanente, Calif., plant, and electric-power cable in its Newark, Ohio, plant. This company had not previously produced either of these products. At Listerhill, Ala., the Reynolds Metals Company completed an $8,000,000 expansion program which provided increased facilities for producing aluminum foil, bar, rod, wire, and cable.

Production of primary aluminum in the United States during 1949 reached a total slightly over 1,200,000,000 lb, it was indicated.

The aluminum industry experienced a shifting change in demand for its products during 1949, the report said. It entered the year with demand far in excess of the industry's capacity. During the second quarter this situation was reserved, which permitted the industry to build up an inventory of the metal—something that had been impossible since 1946 when the unprecedented peacetime demand for aluminum really got under way. In the early fall, however, demand again swung upward and this trend has continued to the end of the year. The industry thus enters the new year with production at a high level.

Shipments of aluminum sheet, plate, and strip by Association member companies exceeded 800,000,000 lb during the year, it was reported. This compares with 1,250,469,806 lb for 1948, according to Bureau of Census figures. Member companies of The Aluminum Association account for more than 98 per cent of the U. S. total of these items.

Production of aluminum castings during the first three quarters of the year totaled 222,479,000 lb compared with 322,562,000 lb during the first three quarters of 1948. Casting production during the last quarter was expected to approach that during the last quarter of 1948. Sand castings represent about 35 per cent of the total, permanent mold (including semipermanent mold) castings another 35 per cent, and die castings about 28 per cent.

There was no change during 1949 in the price of primary aluminum pig and ingot. Aluminum still is the only major engineering and construction material selling considerably below its prewar price level.

The price of secondary aluminum, which had been above that of primary metal during 1948, dropped below the primary metal price in the early months of 1949 as the supply situation eased.

Architectural uses continued to head the list of various classes of application of aluminum during 1949 as it had in the preceding three years. The use of aluminum continues to increase in all types of building construction, but particularly in commercial buildings. A notable example is the new United Nations Secretariat Building rapidly nearing completion in New York in which more than half a million pounds of the metal is used for the framing members of the window-walls covering the two major sides of the building.

A method of construction using cast-aluminum wall panels backed by lightweight concrete insulating slabs was introduced into a 4½-story mill office building during the year. This method meets all building-code requirements and already has been selected for use in a 5-story hospital building and a 30-story office building.

More aluminum also is entering into the construction of smaller buildings and in houses. The most widely used elements continue to be windows, screens, combination screens and storm sash, gutters and down spouts, and heating ducts. Aluminum roofing, siding, and insulation also are widely used in small commercial buildings and houses.

Transportation equipment, cooking utensils, industrial machinery and equipment, and electric cable were among the large users of aluminum during 1949 as in previous years. Electric wire and cable showed a large increase during the year, with all of the major producers either adding or planning to add new cable-producing equipment.

In aluminum foil, the accent was on the home and new uses are being discovered by housewives almost daily. Large quantities of foil continue to be used for packaging all types of products, particularly foods, and for thermal insulation in buildings.

Steel Capacity

STEEL capacity in the United States now closely approaches 100 million tons a year, according to the American Iron and Steel Institute.

That record high level was attained by an increase of 3,271,870 tons during 1949, to an annual potential of 99,392,800 net tons of ingots and steel for castings. In other words, the output from steelmaking furnaces, operated at capacity for one year, would now be about 11 million tons more than the steel made last year in all the rest of the world combined.

The year's increase, second largest in any year since 1940, is half again as large as originally expected. Steel companies were more successful than had been anticipated in pushing this part of their costly programs of expansion and improvement. In the past three years the companies have added nearly 8.2 million tons to steel capacity.

Since 1940 steel capacity has risen nearly 22 per cent, as compared with an increase of approximately 15 per cent in population of the continental United States. During the 1940's the increase in steel capacity measured nearly 18 million tons and was nearly equal to the combined expansion in the 1920's and 1930's.

Additions to capacity in the past few years represent net gains after worn-out and obsolete equipment was discarded, thus placing the condition of furnaces and machinery on a high standard.

Since the beginning of the century steel capacity has been more than quadrupled. Steel capacity per capita of population, now over 1300 lb, is at a peacetime record, and more than twice as great as early in the century.

To support the great increase in steelmaking capacity, other facilities, such as those for raw materials and finishing, have been improved and expanded. Blast-furnace capacity as of January 1, 1950, is rated at 71,497,540 net tons annually, a rise of nearly one million tons in a year and a net of more than 4 million tons over 1944, wartime peak. Current blast-furnace capacity provides for slightly over one million tons of ferroalloys and the balance in pig iron.

Coke-oven capacity also has attained record volume, the January 1, 1950, figure being nearly 65.5 million tons after a gain of more than half a million tons in a year.

Much new and modernized capacity has been added in the past year for working ingots into finished products. This has been particularly true in the fields of cold-rolled sheets and various kinds of tubular products.

To operate its new capacity at full rate the steel industry would require 134 million tons of iron ore in 1950, and 109 million tons of coal. This quantity of coal would be equal

to nearly one quarter of last year's reduced output of coal, or nearly twice as great as the proportion of output used by the steel industry in recent years.

Of more than 8 million tons added to steel capacity in the past three years, nearly 6 million has been open-hearth, about 1.8 million electric, and nearly 400,000 Bessemer. The latter's rise in 1949 was largest since 1940.

Metal Bonding

SINCE the publication of the abstract "Jet-Propelled Airliner," in the October, 1949, issue of MECHANICAL ENGINEERING, page 840, numerous inquiries have been received regarding the Redux metal-to-metal bonding feature employed in the structural design of this aircraft, and briefly mentioned in the article. The airliner was the DeHavilland Comet and the orginal article appeared in *Engineering*.

Because of the interest displayed concerning this bonding method the following summary of the Redux process has been prepared:

The Redux process employs the excellent adhesive properties of synthetic resins for the bonding of metal to metal and metal to certain other materials such as wood and plastics. It is an adhesive of the phenol formaldehyde type and its durability is of the same class as the phenolics.

The process was developed by Aero Research, Ltd., Duxford, Cambridge, England. Production of this adhesive in the United States was undertaken by the Resinous Products & Chemical Company early in 1944. Since that time both companies have been co-operating in its continuing development.

The development of Redux resulted from a need for joining thin metal sheets with maximum smoothness for aerodynamic purposes, without the irregularities that result from riveting, or the heat distortion that usually accompanies welding. The first development work was in the aluminum alloys, usually employed in aircraft construction, but it soon was found to be equally useful with many other important metals.

The process is based on the use of two separate components, a liquid and a powder. The liquid is a clear, reddish-brown, low-viscosity solution which is heat-reactive and should be refrigerated at 35 to 40 F, under which condition it has a storage life of two months or longer. The powder is a stable, white granular solid, which should be kept dry, and which has indefinite storage stability.

It is of the utmost importance that metal surfaces be thoroughly cleansed and freed from oil or grease immediately before the liquid is applied. This may be done by solvent wipe, vapor degrease, or by immersion in a heated acid bath, all as explained in British Specification D.T.D. 915. After such treatment the metal surfaces should be washed and dried. An alternate method is abrasion by steel wool, sandpaper, emery paper, or sandblasting, after which surfaces should be washed, wiped, and dried to remove all dust particles. A slightly roughened, rather than a smooth or polished metal surface is desirable for strong durable joints.

The liquid is applied to the clean metal surfaces by spray, brush, or roller coating. The amount of spread should be 40 to 50 lb per 1000 sq ft of joint, or about 20 to 25 lb on each surface. In most instances the spreading of both mating surfaces is desirable.

Immediately after applying the liquid, the powder should be sifted on the wet surface, enough to cover it entirely, and any surplus removed by light tapping.

The powdered surfaces should be allowed to dry in order to permit solvent evaporation. For small areas 5 min may be found adequate, but for substantial areas 30 to 60 min is a safer basis to eliminate the hazard of steam blisters. Periods from 8 to 24 hr are permissible, and in some cases several days can be allowed.

After the solvent has dried, the two coated surfaces are placed together, taped to maintain proper alignment, and pressed between steam-heated platens, or other pressure-heat devices, for a period ranging from 50 min at 240 F to 9 min at 340 F. During the bonding operation the Redux combination first goes through a stage of plastic flow, during which the two components become intimately mixed, and then fuses to the metal surfaces, resulting in a strong durable bond.

The pressure applied should be adjusted to produce glue lines from 0.002 to 0.006 in. thick. While pressures of 50 psi have been found adequate when surfaces of small area are well fitted, usually it is found advisable on most assemblies to use from 300 to 500 psi to bring the entire area into close contact to insure uniformly thin glue lines.

Various tests such as temperature, fatigue, and immersion tests indicated that metal-to-metal bonds with Redux have passed vigorous government inspection and that such bonds rank high in durability. While this is a development promoted largely during the war years, the net result is a superior metal-to-metal adhesive that is now available for a wide range of industrial uses.

An interesting application utilizing Redux is cementing together metal-faced plywood, where welding heats would damage the wood layers and rivet punching through a relatively soft center layer would be difficult. Other important applications are the lap-welding of large sheets; attaching brackets and lugs to such sheets; gluing cast and forged parts on sheets; combining metals and plastics in various types of laminates, such as in refrigerators, lighting fixtures, closures for metal containers; attaching stiffener bars to metal sheets; assembling metal sash; and the like.

The initial experiments in the bonding of aircraft structures begun during the war, carried out in conjunction with de Havilland Aircraft Company, Ltd., Hatfield, proved so successful that de Havillands decided to adopt the process for making parts of the "Hornet" single-seat fighter.

Perhaps the most impressive of the parts bonded at that time were the 34-ft-long center sections of the Hornet spars.

Soon after the war ended, Vickers-Armstrong, Limited, Weybridge, designed a plywood floor stiffened by "Duralumin" members for their "Viking" civil airliner. By using Redux to attach the metal to the wood they obtained a floor free from rivet or bolt heads and of a very low weight. An interesting aspect of this job was that it was decided to attach the Duralumin stiffeners to the plywood by means of a two-stage process. First, the stiffeners were veneered by means of the Redux process in a hot press. It is possible to put ten 6 ft-long stiffeners in a 3-ft-wide press and bond them in about 15 min. Allowing for the time required to load and unload the press, 180 ft of stiffener per hr could be conveniently veneered. The veneered metal was then cold-glued to the underside of the plywood floor using the cold-setting gap-filling "Aerolite 300" wood glue.

The part played by Redux in in-flight refueling equipment is inconspicuous yet vital. The container for the tanker's contact line is subject to considerable stresses as the line is passed out at speed. It must therefore be of rigid construction and the materials used in its manufacture must not cause sparking, through contact with the moving line, during the operation. For this reason steel was considered unsuitable for the contact-line container and brass was chosen as the material to be used for its construction.

The container has a honeycomb appearance and consists of

separate corrugated brass plates bonded together, the front and rear edges being finally bound with brass strips. Thirty-seven plates are required for a single container of 3 ft height, $4^1/_4$ in. width, and 12 in. length, and Redux is used both for the bonding together of the plates and for the final attachment of the top and bottom brass strips at each end. The choice of this method for this purpose is particularly interesting for it is the first time that this process of bonding has been used on a large scale for joining brass to brass. The first units were assembled by sweating together the corrugated sheets, but it was found that the flux could not be satisfactorily washed from the joints and corrosion was therefore possible. Redux does not cause corrosion, and greatly increased output is achieved without detriment to outstanding strength of bond.

Panels of sandwich construction are used for bulkheads on the Avro "Tudor" airliner and for floors on the Chrislea "Ace" light plane. In both of these aircraft, which are of course of very different types, the panels consist of thin sheets of "Alclad" bonded to either side of the resin-bonded plywood. Naturally, the thickness of the plywood and the gage of the Alclad vary in the two applications and there is of course almost no limit to the possible variations. In another aircraft, still on the secret list, the bulkheads are made in a slightly different manner. In manufacturing these panels, veneers of wood are first Redux-bonded to the Alclad which is then cold-glued to Dufaylite lightweight honeycomb material. In every case the procedure for the bonding is similar. The plywood is sanded lightly and then Redux liquid is brushed on to it while the Alclad is degreased and pickled so as to remove corrosion; the liquid is then brushed on to it, followed by dipping in Redux powder. The metal sheets are placed on either side of the wood and the assembly bonded at pressure of 100 to 200 psi for 15 min at 293 F.

Redux bonding has also been used for bonding a sheet-aluminum top to a hardwood frame to make carpet-sweeper boxes.

Quite a different proposition is the bonding of $^1/_2$-mm-thick walnut veneers to both sides of some 12-in-diam half-hard aluminum disks. After removal from the press the disks are damped and pressed to form fruit bowls.

Facia panels for the Hillman "Minx" were produced by bonding attractive walnut veneers to steel pressings. The steel pressings are degreased and sanded. Redux liquid and powder are applied to them and then they are put on jigs in a hot press. Walnut veneers are placed on top of the pressings, and sheets of rubber are in turn placed on the veneers. The purpose of the rubber is to accommodate the slight variations in the thickness of the veneers and steel pressings and thus avoid excessive pressure on some parts of the veneer. Such local high pressures are liable to crush and discolor the wood. The press is then closed and the bonding of veneer to metal carried out in 15 to 20 min.

After their experience with the bonding carried out at Duxford, de Havillands equipped a large workshop for carrying out the process, and have made extensive use of it on their aircraft. Following production of the wartime "Hornets" and "Sea Mosquitos," they began to build all-metal "Dove" airliners. More than 200 of them are now flying and they all have large parts of their structures bonded together by Redux.

As a contrast to the gluing of metal aircraft, Venesta, Limited, for several years now have been producing sheets of veneered aluminum marketed under the trade name of "Vendura." This material has many advantages over plywood; it can be cut and formed in much the same way as sheet metal, and it is resistant alike to fire and insects. An interesting effect can be obtained by machining away the wood veneer and thus reveal the underlying aluminum in attractive designs; it is therefore an ideal material for interior decoration. In addition, Warwick Rim & Sectioning Company, Limited, West Bromwich, are now cold-rolling strips of veneered aluminum so as to produce "Venduraform."

Recently Ciba, Limited, Basle, Switzerland, have introduced "Araldite," another synthetic resin for bonding metals. The advantage of this new adhesive is that it requires hardly any pressure during the actual bonding operation, but it requires rather higher bonding temperatures, e.g., 40 min at 392 F or 10 min at 464 F. Redux is clearly more suitable for gluing veneers to metal, because wood will not withstand the temperatures required for curing Araldite, but on the other hand, Araldite is the obvious choice for bonding a metal tube into a socket where it is not possible to apply pressure to the joint. In addition, Araldite may be used for gluing metals to quartz, mica, porcelain, and glass, materials to which it is very difficult to secure good adhesion.

Information on the foregoing was obtained from the following sources: (1) "Metal to Metal Adhesives," by Thomas D. Perry, *Plastics*, February, 1947. (2) "Metal Bonding," by C. J. Moss, *Metal Industry*, Aug. 12, 1949. (3) "Aircraft Refueling During Flight," Aero Research Technical Notes, Bulletin No. 69, September, 1948. (4) "Wood-to-Metal Adhesives," by Thomas D. Perry, MECHANICAL ENGINEERING, vol. 68, 1946, page 1035. (5) "Facia Panel Manufacture," by C. J. Moss, *Automobile Engineer*, April, 1949. (6) "Vendura," Aero Research Technical Notes, Bulletin No. 78, June, 1949. (7) Aero Research Technical Notes, Bulletin Nos. 39, 48, 49, and 55.

Retractable Amphitheater Roof

DESIGN of a large amphitheater with a mechanical retractable roof of plastic fabric, recently completed for the City of Pittsburgh, Pa., will provide permanent facilities for the city's outdoor light opera and protect the opera management from recurrent heavy losses caused by rained-out performances, according to *Civil Engineering*, February, 1950. It is said to be the first structure of its kind in the world, and was designed by Mitchell and Ritchey, Pittsburgh architects, with Ammann and Whitney, New York, N. Y., as consulting engineers.

The retractable roof support is a giant cantilever steel frame extending from the rear to the center of the amphitheater where it terminates in a central mast overhead, to which the roof's supporting cables are attached. In the rear area where

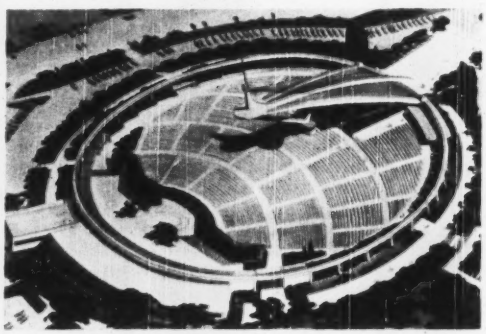


FIG. 5 ARTIST'S CONCEPTION OF PROPOSED RETRACTABLE AMPHITHEATER ROOF

the cantilever support is visible, there will be no seating, and the space will be used as an inner lobby and for concession facilities. A control booth, suspended from the cantilevered frame will house the operating mechanism for the roof, sound-control machinery, and spot lighting. Peripheral illumination will provide additional spot lighting. The roof will be, in effect, a flexible fabric tent, composed of pie-shaped segments that fan out when unfurled from either side of the cantilever frame. A new synthetic fabric, offering high tensile strength and resistance to flex, weathering, and atmospheric conditions, is planned for the roof covering. The fabric roof will have a radius of 185 ft, leaving a 12-ft gap around the amphitheater where a huge circle of planting pockets serve as a continuous gutter.

Tracks to carry the cable trolleys and the tractor for the boom, which supports and guides the fabric, will be mounted on a circular ring girder 400 ft in diam and enclosing the whole amphitheater. Abutments built at 30-ft intervals and circling the amphitheater at a radius of 200 ft support this ring girder. Two rigid structural arms or booms forming the leading edges of the roof are propelled by a pair of 50-hp electric tractors that operate on the ring girder's boom track. The roof will be unfurled in two halves operating simultaneously, the whole process requiring about 2½ minutes. Operation will be relatively noiseless.

When completed, the project will provide enclosed protection for an audience of 9500 and the entire stage with its storage and subsidiary facilities. The estimated construction cost of the retractable roof and supporting structure is $542,000.

Air-Crash Research

THE Air Material Command's Aero Medical Laboratory has devised a new human decelerator which is expected to increase crew members' chances for survival after an aircraft crash, according to the *Technical Data Digest*, February 1, 1950. The device scientifically duplicates crash-landing conditions.

The decelerator was built by Northrop Aircraft, Inc., of Hawthorne, Calif., and has been installed at Edwards (formerly Muroc) Air Force Base. It consists primarily of a 1500-lb carriage slipper-mounted on a 2000-ft standard-gage railway track supported on a heavy concrete bed, and a 45-ft mechanical braking system believed to be the most powerful ever constructed. Four slippers secure the carriage to the rails while permitting it to slide freely.

The carriage is rocket-propelled into the series of preadjusted mechanical brakes. Conditions of deceleration are controlled by varying the number of rockets and the number and pattern of brake sets used. Tests have shown that if proper body support is provided, the human body has an amazing toughness in withstanding the tremendous forces of a crash.

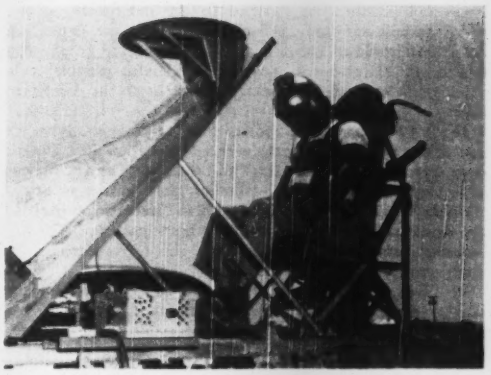


FIG. 7 ONE OF AIR MATERIEL COMMAND'S VOLUNTEERS STRAPPED IN POSITION FOR TEST RUN

(Some tests have been made with cab fastened on; others took place with just a windshield for protection.)

Human volunteers have already completed one series of tests in gradual increases up to 35g in both forward and backward facing positions. When subjected to this much decelerative force, the volunteer's body is momentarily pressed against his seat support or harness by a pressure equal to 35 times the weight of his body. In the case of a man weighing 175 lb, this pressure would be 6125 lb. If unprotected, he would be hurled against the aircraft structure with the same force.

A deceleration of this type is obtained by slowing the carriage and rider from 150 mph to 75 mph in one fifth of a second. The volunteer experiences the same sensation an automobile driver would have if he stopped his car, which was traveling 75 mph, in just nine feet.

In tests involving the forward-facing position, the volunteers are provided with a modified seat harness consisting of web straps pressed over the lap, around each thigh, and over each shoulder. The thigh straps were found to be needed to prevent the lap belt from riding up and striking the abdomen in case of a crash.

Seated in a backward-facing position, with the back of the seat providing support during the deceleration tests, the volunteers withstood 35g easily. Most of today's military and civilian transports are fitted with forward-facing seats stressed to take 6g or less.

In a test run, the volunteer is first subjected to a thorough physical examination, and then strapped in position. He may be facing forward or back, or even be lying down because the Aero Medical Lab's technicians are considering that position for certain crew members.

Instruments to measure

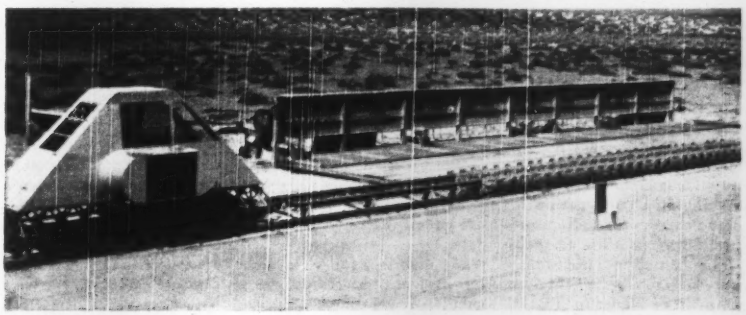


FIG. 6 OVER-ALL VIEW OF HUMAN DECELERATOR FOR SCIENTIFICALLY DUPLICATING AIR CRASH-LANDING CONDITIONS

forces and pressures are fastened to the individual, as well as his harness and seat. All changes during the experiment are transmitted as radio signals and recorded in the control room. High-speed movie cameras also provide valuable data to evaluate the immediate effect on the decelerator rider.

The 1000-lb-thrust rockets are fired simultaneously at the rear of the carriage as the volunteer braces himself. The carriage then roars down the track to the braking area. Braking is accomplished by 45 sets of brakes, each consisting of two clasping pairs of brake surfaces 6 × 12 in., installed on the roadbed between the rails. These brake pairs clasp the 11-ft-long braking plates attached underneath the carriage chassis to apply the desired deceleration.

By varying the number and pattern of brake sets and the number of carriage-propelling rockets (there are four), controlled decelerations from 5 to 50g are possible. The maximum velocity of the carriage as it enters the braking area may be as great as 240 mph.

According to a report from Crash Injury Research of the Cornell University Medical College, New York, N. Y., the deceleration tests conducted thus far demonstrate that people can tolerate crash decelerations of 35g, this, in so far as is known today, is more than conventional aircraft structures can withstand without destruction of the cockpit or cabin. It follows therefore that people can, and should, survive aircraft accidents in which cabin structure remains substantially intact.

The Muroc tests, the report states, have also shown that human structure not only can "live through" but can tolerate 35g decelerations with only moderate discomfort. Not only do they show that the body can be protected, but they also demonstrate two ways in which protection can be provided — by use of shoulder harness and by reversed seats.

One result of the Air Force high-g research program is the probability that rearward facing seats will be developed for use in military air transports and will provide information for evaluating reverse seating for future airline use.

Evidence of the protection provided by shoulder harness — in the Muroc deceleration research as well as in actual crashes of fighter aircraft — indicates that an amazing increase of safety will be achieved when such installations are made available in personal aircraft and come into broader use by amateur pilots.

Minimized Fire-Side Deposits

AFTER years of combating excessive fire-side deposits in some of its stoker-fired steam generators, The Detroit Edison Company has apparently found a simple method for minimizing the rate at which these deposits form. The method consists of humidifying the combustion air that is fed through the fuel bed.

These steam generators operate at 860 psig and at a steam temperature of 900 F. They are fired by large, single-ended, underfeed stokers. Especially in winter, the superheaters and economizers have fouled rapidly, the deposits are rich in silicon, sodium, potassium, and sulphate compounds.

Solution of the problem came through a combination of theory and observation. According to theory, the sodium and potassium compounds are volatilized because they are subjected to high temperatures for long periods on the stoker bed. They then condense on the superheater tubes where they react with sulphur trioxide to form a sticky binder for fly-ash particles. Any mechanism that would reduce the fuel-bed temperature should therefore reduce the volatilization and hence reduce fouling. One mechanism that should reduce the fuel-bed temperature without derating the boiler is the water-gas reaction within the fuel bed. The heat withdrawn from the fuel bed by that endothermic reaction should be recovered above the fuel bed as the resulting carbon monoxide and hydrogen burn. Observation revealed that the fouling of the boiler, superheater, and economizer surfaces in the past was a function of the absolute humidity of outdoor air. Further, computation showed that the amount of water vapor entering the fuel bed with the air in summer is sufficient to withdraw an appreciable amount of heat from the fuel bed if that water reacts with the hot carbon. It was therefore reasoned that by humidifying the air to summer conditions, summer behavior might be expected.

This hypothesis appears to be true. Not only is there a saving through better availability and lower maintenance, but also, as judged by boiler-outlet and stack temperatures, there is a gain in efficiency, even when proper thermal charge is made for the humidification.

Extensive experimental work is being carried out on numerous practical and theoretical phases of the problem. This will be reported later. The first experimentally treated boiler has been running 89 days instead of the usual maximum of 30; the economizer is remarkably clean; and the superheater is only slightly fouled. Probe tests show not only that the amount of material depositing on the superheater tubes is markedly lessened, but also that its composition is altered by the humidification.

20-Million-Volt Cyclotron

THE first cyclotron in the Southeast, a powerful 86-in. machine for the acceleration of protons to 20-million-volt energies, will be ready for use around May 1 as part of the Oak Ridge National Laboratory research program, the Atomic Energy Commission announced recently.

In announcing the new cyclotron, it was pointed out that one reason for its location in the electromagnetic-plant area at Oak Ridge is that advantage can be taken of an existing building and some of the equipment originally installed for the separation of Uranium-235 by the electromagnetic process. Costs will be reduced, it was said, in utilizing some of the existing equipment in assembling the cyclotron. The electromagnetic process for obtaining U-235 is now in stand-by, although research on process improvement is being carried forward.

The cyclotron will be an important addition to research facilities of the Southeast since there is no cyclotron east of the Mississippi and south of the Ohio Rivers. The machine will be useful in fundamental studies of nuclear research and in the production of radioisotopes. Stable isotopes already being prepared in the electromagnetic-plant facilities can be bombarded in the cyclotron to produce certain radioactive isotopes which cannot be produced in the laboratory's uranium chain reactor.

What is believed to be a record in the high-speed assembling of great masses of metal into precision research equipment has been established in the current work on the cyclotron. For instance, 1000 cu ft of steel required for the 250-ton magnet yoke of the cyclotron were installed in only 15 working days.

Meanwhile, a full-scale model of the electric system has been installed in order to test the performance of equipment under simulated operating conditions. A small test cyclotron giving acceleration up to 2 million electron volts has been in operation at the electromagnetic plant for some time.

ASME TECHNICAL DIGEST

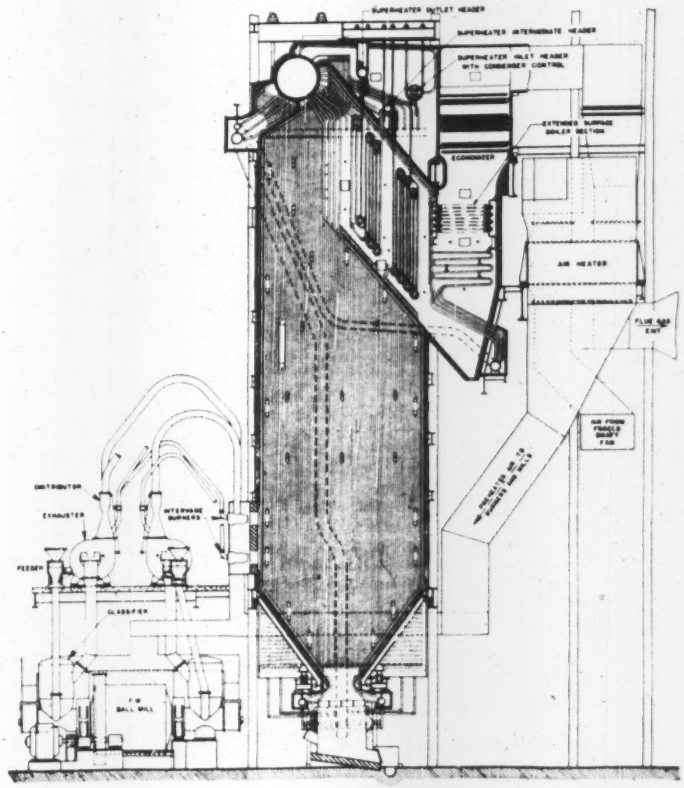
Substance in Brief of Papers Presented at ASME Meetings

Furnace Performance Factors

Furnace-Heat Absorption in Pulverized-Coal-Fired Steam Generator Using Turbulent Burners at Paddy's Run Station, Louisville, Ky.—Part I Variation in Heat Absorption as Shown by Measurement of Surface Temperature of Exposed Side of Furnace Tubes, by R. I. Wheater and M. H. Howard, Mem. ASME, Foster Wheeler Corporation, New York, N. Y. 1949 ASME Annual Meeting paper No. 49—A-118 (mimeographed; to be published in Trans. ASME).

This report is one of three current formal reports covering the activities of the ASME Special Research Committee on Furnace Performance Factors in connection with the furnace-performance tests which were conducted at the Paddy's Run Station of the Louisville Gas and Electric Company in Louisville, Ky.

The furnace-heat absorption and its distribution in the furnace, as reported in this paper, were determined by the ΔT method, which consists of using the difference in temperature between the surface of exposed face of the tube and



GENERAL ARRANGEMENT OF NO. 3 UNIT AT PADDY'S RUN STATION

How to Order ASME Papers

PAMPHLET copies of ASME papers referred to in this section are available, until the supply is exhausted, at 25 cents each to members; at 50 cents each to nonmembers. ASME papers published in full or condensed form in other sections of MECHANICAL ENGINEERING are not included in this Digest Section.

To facilitate ordering papers, coupon books, each containing ten coupons, are available to members at $2 each, to nonmembers at $4 each. These coupons may be used to purchase papers presented at ASME Meetings.

When not using coupons, remittance must accompany all orders of $2 or less.

When ordering, please give number assigned to article, title, author's name, and number of copies wanted. Orders should be sent to the ASME Order Department, 29 W. 39th St., New York 18, N. Y.; or, use convenient order form below.

NOTE: ASME Publications and advance copies of ASME papers are on file in the Engineering Societies Library and are indexed by the Engineering Index, Inc., both at 29 West 39th St., New York, N. Y. ASME Transactions and *Journal of Applied Mechanics* are also on file in ASME depositories maintained in 245 libraries in the United States, including libraries of all ASME Student Branch institutions.

ASME Order Department
29 W. 39th St., New York 18, N. Y.

Date .....

Please send me the papers indicated by the following circled numbers:

49—A-55,	49—A-137,
49—A-68,	48—A-145,
49—A-69,	48—A-146,
49—A-70,	48—A-149
49—A-73,	48—A-150
49—A-78,	48—A-151
49—A-93,	48—A-152,
49—A-117,	48—A-153,
49—A-118,	48—A-154,
49—A-123,	48—A-168,
49—A-126,	48—A-170,
49—A-127,	48—APM-24

Name .....

Address .....

☐Remittance enclosed ☐Bill me

☐ASME Mem. ☐Nonmem.

the mixture within the tube to measure the heat absorption at representative locations.

Part II, a digest of which appeared in MECHANICAL ENGINEERING, January, 1950, page 40, covers the furnace performance as measured by a heat balance of the furnace. Part III (Paper No. 49—A-117) follows.

The object of this paper is to establish the distribution and amount of heat absorption in this furnace as measured by the ΔT method for the various operating conditions investigated and to study the effect of these operating variables on furnace performance. The operating variables studied were burner adjustments, furnace rating, excess air for combustion, and various combinations of burners in service at 50 per cent full load.

Based upon the data and analysis of results, the following conclusions concerning the performance of this furnace under the operating conditions investigated were reached:

1 Ash does not collect in sufficient quantities to affect the heat absorption by the furnace-wall surface at any location other than the area of the rear wall at the burner elevations.

2 Considering the distribution of heat absorption over the height of the furnace, it is found that the average absorption rates are usually highest at the elevation just below the burners.

3 Variations in absorption rates for clean furnace surface throughout the furnace do not exceed a magnitude of 3 or 4 to 1.

4 Opening the secondary-air vanes, in the ranges studied, causes: (*a*) a reduction in heat absorbed by the front walls; (*b*) an increase in ash accumulation on the rear wall opposite the burners accompanied by a decrease in absorption in this area; (*c*) a reduction in absorption rates in the zones of higher absorption on the side walls near the burners; (*d*) a decrease in absorption at the burner elevations and lower absorption rates throughout the furnace; and (*e*) a decrease in furnace efficiency which varies with excess air and heat input conditions.

5 Increasing the excess air for combustion, in the range from 17 to 30 per cent causes: (*a*) a reduction in heat absorption at the burner elevations; (*b*) an increase in ash coverage in that area of the rear wall directly opposite the burners; and (*c*) a decrease in furnace-heat-absorption efficiency with varying characteristics depending upon which secondary-air vane opening is used.

6 Variations in the combination of burners in service, at 50 per cent full load, causes: (*a*) changes in the ash coverage on the rear-wall area opposite the burners; (*b*) variations in the average absorption rates at the burner elevations and the locations of higher absorption zones shift up and down depending upon the burners used; and (*c*) variations in furnace heat-absorption efficiency in the range of approximately 5 per cent.

7 The ΔT method provides a good means of determining the distribution of heat absorption in the furnace, and many of its inherent errors apparently cancel themselves in the determination of the furnace heat-absorption efficiency. However, it is recommended that, wherever furnace efficiency is concerned, the reader should also refer to the heat-balance data contained in Part II of the investigation at Paddy's Run Station.

Furnace Heat Absorption in Pulverized-Coal-Fired Steam Generator Using Turbulent Burners at Paddy's Run Station, Louisville, Ky.—Part III Comparison and Correlation of the Results of Furnace-Heat-Absorption Investigation, by H. H. Hemenway, Jun. ASME, and R. I. Wheater, Foster Wheeler Corporation, New York, N. Y. 1949 ASME Annual Meeting paper No. 49—A-117 (mimeographed, to be published in Trans. ASME).

In this paper the results of Parts I and II are compared. Some of the possible sources of error are noted. Slightly revised calculated results are obtained by taking weighted averages of the data. The revised results are examined to determine which tests are the most dependable. An equation showing the relationship between furnace exit gas temperature and furnace heat-absorption rate for a fixed burner adjustment is developed. From the revised results the effect of various factors on furnace performance is shown.

It is concluded that:

1 With care in testing, furnace performance may be determined by either the heat-balance method or the ΔT method with a fair degree of accuracy.

2 The over-all average heat-transfer coefficient, through the tube wall and inside tube film was 1030 to 1050 Btu/(hr) (F) (sq ft projected area). From this, the calculated film coefficient is 5500 Btu/(hr) (F) (sq ft of inside tube wall surface).

3 For 8-burner operation with secondary air vanes 40 per cent open, the average heat-absorption rate Q, the average furnace exit-gas temperature T_0, and the average furnace tube-face temperature T_w are related as follows:

$$Q = 1060\left[\left(\frac{T_0}{1000}\right)^4 - \left(\frac{T_w}{1000}\right)^4\right]$$

4 In general, the conclusions of Part I and Part II, with some slight modifications to the calculated results found in Tables 1 and 2 of this paper, are valid.

Textiles

The Modern Concept of Industrial Air Conditioning, by P. L. Davidson, Mem. ASME, consulting engineer, Philadelphia, Pa. 1949 ASME Annual Meeting paper No. 49—A-137 (mimeographed).

Textile air-conditioning developments are outlined in this paper which points out that the phrase "air conditioning" had its birth in the textile industry, where the process of controlling the temperature and humidity of the air within mill interiors was primarily considered as conditioning yarn by means of air.

Responsible for changes in air-conditioning systems are the invention of hundreds of new machines like the double-deck twister, and the design and production of new fibers to meet the varying fashion trends requiring sudden changing of the arrangement of machine operation. The substitution of fibers such as nylon for silk, rayon for cotton, or spun for filament yarns requires changes in the relative humidity required for the process. This change in styling necessitates changes in the capacity or distribution of the air-conditioning system.

The days of moisturizing the air by wetting the floor with a hose or by mechanically spraying moisture into the air are over, the paper points out. Recent years have brought several new engineering developments, among which are the unitary and central-station systems of air conditioning, electrostatic filters, the elimination of windows in factories, changes in wall structures and insulation techniques, refrigeration, and several others.

Machine Design

The Influence of Shape of Cross Section on the Flexural Fatigue Strength of Steel, by T. J. Dolan, Mem. ASME, and W. J. Craig, Engineering Experiment Station, University of Illinois, Urbana, Ill., and J. H. McClow, Cook Research Laboratories, Chicago, Ill. 1949 ASME Annual Meeting paper No. 49—A-55 (in type, to be published in Trans. ASME).

It is not generally known or recognized that the flexural fatigue strength of a beam may be influenced to an appreciable extent by the shape of cross section of the member. In order to obtain further information on the magnitude of this shape effect, flexural fatigue tests were

made employing four different shapes of cross section for each of two different steels. The results of these tests are compared and analyzed to clarify or explain some of the shape factors that may be of importance in affecting fatigue behavior.

Laboratory studies indicated that the flexural fatigue strength of a member was influenced to an appreciable extent by the shape of cross section; steel beams of circular cross section exhibited fatigue limits 8 to 10 per cent greater than the fatigue limits of beams of square cross section. Beams having a diamond cross section (square beams stressed with the neutral axis as a diagonal of the diamond) exhibited endurance limits from 4 to 8 per cent less than the round beams.

The susceptibility to localized inelastic action, as governed by the shape of cross section and by the presence of sore spots, such as outward projecting corners, is tentatively believed to be the primary element leading to the reduction of fatigue strength of the square and diamond shapes to values below that for the round. While the other factors (residual stresses, alterations of properties due to machining, and statistical aspects of the amount of material subjected to peak stress) may have been of some influence in these tests, it is felt that their effect on the fatigue strengths of beams of the shapes studied were of a minor nature.

Oil Lubrication of Ball and Roller Bearings, by J. P. Critchlow, Gulf Oil Corporation, Pittsburgh, Pa. 1949 ASME Annual Meeting paper No. 49—A-123 (mimeographed).

Lubrication has been a recognized necessity as long as there have been bearings but it has been only recently that investigations have been made into the reasons why certain lubricants were more effective than others for various bearing applications. These investigations have led to a better understanding of the functions of a lubricant in a bearing and have resulted in the development of highly refined and highly stable petroleum lubricants, suitable for the lubrication and protection of all types of ball and roller bearings operating under almost any condition.

In general, the required functions of a ball or roller-bearing lubricant are as follows: (1) reduce friction between the sliding elements of the bearings, (2) reduce rolling friction or rolling resistance, (3) prevent rust and corrosion of bearing parts, (4) dissipate heat generated in and heat conducted into bearings, and prevent, in so far as possible, the entry of contaminating materials into the bearing.

Sliding friction in ball and roller bearings is the result of the rubbing action of the balls or rollers and their separators, the slippage between rollers and guide flanges, and the rubbing of rolling elements when no separators are used.

Rolling friction or rolling resistance is a much more involved phenomenon and results from the deformation of the rolling elements and their raceways under load.

Some of the more common oil lubricating methods and devices for ball and roller bearings discussed were as follows: oil bath—constant-level oiler, splash feed, sight-feed oiler, wick-feed devices, circulating systems, and oil-mist systems.

Lubrication

A Mathematical Evaluation of Pressures in a Grease-Lubricated Bearing, by K. B. Lawrence, Pennsylvania State College, State College, Pa. 1949 ASME Annual Meeting paper No. 49—A-69 (in type, to be published in Trans. ASME).

Of the various methods proposed in the past for the numerical evaluation of pressures developed in a film of lubricant, perhaps the best method, in general, consists of the application of a finite-difference formula developed from the fundamental differential equation. Such a formula has been developed by Derman G. Christopherson, who also has shown that the formula gives accurate results when applied to calculations involving oil-lubricated bearings. The author herein applies the finite-difference formula to calculations of the pressure distribution existing in a grease-lubricated bearing and compares the results obtained with the results of a recent experimental investigation by Cohn and Oren, which was conducted under similar conditions of operation.

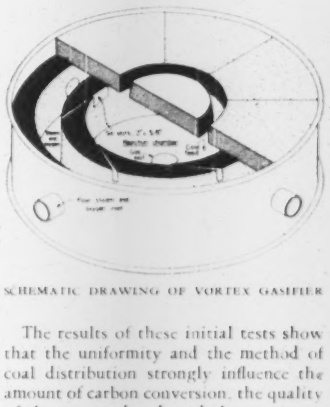
Fuels

Continuous Gasification of Pulverized Coal With Oxygen and Steam by the Vortex Principle, by H. Perry and R. C. Corey, Mem. ASME, Bureau of Mines, Pittsburgh, Pa., and M. A. Elliott, Mem. ASME, Bureau of Mines, Bruceton, Pa. 1949 ASME Annual Meeting paper No. 49—A-73 (in type, to be published in Trans. ASME).

The manufacture of synthetic liquid fuels by the Fischer Tropsch process, which appears to be a future commercial possibility in this country, requires approximately 30,000 scf of hydrogen and carbon monoxide (synthesis gas) for each barrel of product. Although synthesis gas can be made from oil, natural gas, or coal, it is obvious that if synthetic fuels are to supplement a substantial percentage of the liquid fuels consumed in the future, coal must be looked to as the primary source.

This progress report presents the preliminary results of the gasification of pulverized coal by steam-oxygen mixtures in a vortex reactor. The basic principles of reactor design, and an illustrative example of their application are given. A method of calculating the composition of the gas produced in this reactor is presented and has been checked experimentally.

The tests confirm the assumption that from the knowledge of the feed conditions, heat losses, and the per cent carbon gasified, the approximate composition of the gas produced can be predicted for this reactor. In these tests the carbon conversions were low, and the resulting make gas was high in carbon dioxide. For a given set of feed conditions any means of increasing the carbon conversions will improve the quality of the gas. In order for this reactor to be commercially feasible the carbon conversions must be increased.



SCHEMATIC DRAWING OF VORTEX GASIFIER

The results of these initial tests show that the uniformity and the method of coal distribution strongly influence the amount of carbon conversion, the quality of the gas produced, and the maximum and minimum throughputs. The conical coal distributor was unsatisfactory in that the coal was fed nonuniformly near the outer perimeter of the vortex. The few preliminary tests with the spinning-plate distributor suggest that these difficulties have been overcome.

Other possible methods of increasing the carbon conversion are available, i.e., (1) using a coarser size consist of coal with the spinning-plate distributor, (2) increasing the height of the reaction chamber, and (3) increasing the tan-

gential velocities at constant coal rates. Further tests are planned with the new distributor when the mechanical difficulties have been overcome, and the effect of the foregoing variables on the carbon conversion will also be investigated.

Process Industries

Oil-Refinery Waste Treatment, by E. M. Proctor, Redfern & Laughlin, Toronto, Ont., Canada. 1949 ASME Annual Meeting paper No. 49—A-78 (mimeographed).

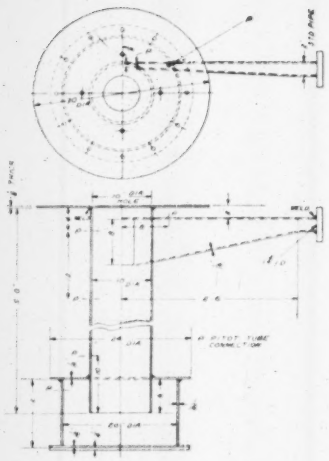
In the standard oil-separation tank, where oil is floated off, the emulsions will flow through the separation tank, and upon an analysis of the effluent, a high oil content is found. These emulsions, when highly diluted in the receiving lake or river, break up and, as a result, the oil floats to the surface.

To correct such a condition a method of handling these emulsions wastes is described. The results obtained in this plant show conclusively that the emulsions when passed through the main separation tanks, without any treatment for breaking them down, have a decided effect on the oil content in the daily tests of the effluent. With the emulsion properly treated, the final tests show an even content of oil in the effluent. A chart which accompanies this paper shows these results in a graphic manner. One part of the chart shows the oil content in the effluent in August, 1945, before the oil emulsions were separately treated. Another part shows the results in August, 1947. The average has been reduced from 42 to 5 ppm and the irregular results in 1945 have been eliminated.

The Reduction of the Pressure Drop Across Vortex Dust Collectors, by F. B. Schneider, Mem. ASME, General Electric Company, Erie, Pa. 1949 ASME Annual Meeting paper No. 49—A-126 (mimeographed).

The greatest disadvantage of vortex dust collectors is the large pressure drop caused by the whirling motion of the gas while performing the cleaning action. Even small reductions of the pressure drop will provide substantial savings in power consumption.

In attacking the problem of reducing the high pressure drop, care must be taken not to destroy the vortex in the long separator cylinder, since this would seriously affect the dust-separating efficiency. If the vortex were changed to a flow of constant angular velocity, the pressure drop would be decreased considerably, but the apparatus would lose most of its value as a separator.



VORTEX COLLECTING APPARATUS

Generally, the outlet of a collector, consisting of the rim of the inner cylinder leads into a reducer fitting which connects to a pipe of the proper dimensions. Nothing is done to prevent the spinning of the gas before it enters into curved pipe sections; therefore the pressure drop encountered is usually very high.

One way to straighten the spinning flow into parallel flow is to let the discharge whirl from the collector expand into a cylinder with a closed top. The rotating mass of air is forced to reverse its axial-flow direction. It spirals along the cylinder walls and discharges with straight parallel flow into a tangential outlet near the level of the central entrance.

Tests with a pressure-drop reduction device, which obtains a 47 per cent reduction in pressure drop, are described in this paper.

An analysis of the air-flow patterns is furnished which places the cause for the recovery of pressure drop on the conversion of kinetic energy into static pressure in the recovery cylinder and on the elimination of the central downdraft in the inner cylinder of the collector.

From the tests it has been established that it is possible to create a vortex flow in a long slender cylinder simply by rotating a small central region of air with constant angular velocity. The application of this principle makes it possible to employ pressure recovery cylinders, not only on vortex collectors, but also on those of the centrifugal type.

Cyclone Dust-Collector Design, by Melvin W. First, Harvard School of Public Health, Boston, Mass. 1949 ASME Annual Meeting paper No. 49—A-127 (mimeographed).

Velocity, pressure, flow direction, and dust gradients were measured in geometric cyclones of graduated size and in cyclones embodying changes in characteristic dimensions. The effect of cyclone size, shape, and air-flow rate on cyclone energy loss and efficiency are related to the internal dynamics of the collector. An energy-loss equation in terms of cyclone dimensions is developed.

The study was undertaken to obtain more detailed information on flow pattern and dust distribution in operating cyclones by systematic study of the effects of change in significant cyclone proportions.

According to the paper, static pressure and flow direction in cyclones of various designs and sizes demonstrate that energy loss is directly related to internal cyclone velocity, and that energy loss results from internal shear of adjacent gas strata rotating at different speeds and at different flow angles. Cyclone dimensions found to be significant in cyclone energy loss are entry height and width, exit-duct diameter, the ratios of cylinder and core height to cyclone diameter, and the presence or absence and type of entry vane. Entry vanes completely closing off the annular space in the cyclone induce a double eddy-type flow in the upper half. All other designs show a well-defined double spiral flow.

Dust studies indicate that cyclones having narrow entries without vanes possess important advantages for high-efficiency performance. Dust gradients show that gas-flow rate is not a major variable in determining cyclone efficiency.

Pressure-Vessel Research

Allowable Eccentricity of Spherical Heads Convex to Pressure, by R. G. Sturm, Mem. ASME, L. W. Smith, Purdue University, West Lafayette, Ind., and H. L. O'Brien, Jun. ASME, Graver Tank and Manufacturing Company, East Chicago, Ind. 1949 ASME Annual Meeting paper No. 49—A-70 (in type, to be published in Trans. ASME).

The design of spherical shells or pressure vessels with heads of spherical contour subject to external pressure or pressure on the convex side is complicated by the unavoidable initial out-of-roundness of the manufactured shell or head.

Beside the basic concepts of the strength of materials, other factors, such as secondary stresses due to bending, must be recognized as contributors to buckling action.

The analysis presented herein leads to curves which may aid designers in proper selection of spherical-shell or head thicknesses when manufacturing tolerances are considered. It is hoped that such curves will be of value to the ASME Code for Unfired Pressure Vessels.

The type of eccentricity is an important factor. Th. von Kármán and H. Tsien pointed out that a full cup deflection is a stable condition, but a flat deflection is very unstable. The size of the deformed area is also a critical factor.

Investigators have attacked the problem in two general ways. Von Kármán and Tsien have used the theoretical approach as applied to thin shells, whereas Zick and Carlson, and Mariner and Keith have approached the problem from the experimental viewpoint.

This paper treats each shell as a departure from a perfect shape in which the bending stress contributes to yielding and collapse. The methods used are primarily analytical and follow similar analytical studies for cylindrical vessels. The analysis for cylindrical vessels has been substantiated by tests and serves as the basis for computing allowable out-of-roundness charts for the present ASME Code for Unfired Pressure Vessels.

Mechanical Testing, Experimental Stress Analysis, and Apparatus in Pressure-Vessel Research, by F. G. Tatnall, Baldwin Locomotive Works, Philadelphia, Pa. 1949 ASME Annual Meeting paper No. 49—A-68 (mimeographed).

This review was prepared for those who must interpret test data into design improvement and safety in structures.

Stress analysis is a mathematical survey of the stress level in a proposed structure involving estimates of expected service loads and assumptions to cover both the unknowns of dynamics in the structure and its design indeterminates.

Testing consists of the following: (1) Laboratory tests on machined specimens to find the static and fatigue strength of materials; (2) tests of the static and fatigue strength of structural components and assembled parts to see how the basic strength is modified by its use in the structure; (3) experimental stress analysis to check the actual stress level, and thereby to correct assumptions; and (4) the experimental determination of actual loads on the structure in service to correct the estimate on loads. This latter of course can be done only after a structure has been first built from computed analysis.

SR-4 bonded wire strain gages are the most commonly used instruments for three phases of testing: First, for determining service loads. Second, for static tests of the structure where the structure may be loaded hydrostatically, by dead weights, or by hydraulic jacks, or otherwise. This test shows if all parts are taking their share of the load, and if not, points out the possible correction of the condition. Stresscoat is often used as a means of pointing out areas of maximum stress so they can be evaluated precisely with strain gages. Third, for dynamic testing where a component or part or a whole structure may be alternately loaded in a fatigue machine or in the field and the stress concentrations pointed out by Stresscoat and evaluation by strain gages feeding into oscillograph or oscilloscope circuits.

The usual laboratory fatigue test of machined specimens is the rotating beam, a completely reversed bending of a beam loaded by dead weights at its third points to provide constant bending moment over the central test section. The speed of operation is 10,000 rpm. Notches, screw threads, and welds can be used in the test section, and corrosion-fatigue testing is accomplished by running the specimen very slowly in a chamber filled with the corrosive medium. Cantilever rotating beams are sometimes employed instead of the simple beam.

For structural fatigue the oldest form is pulsating a fluid-filled pressure vessel with valveless piston pumps. It is now proposed to do this up to 50,000 psi.

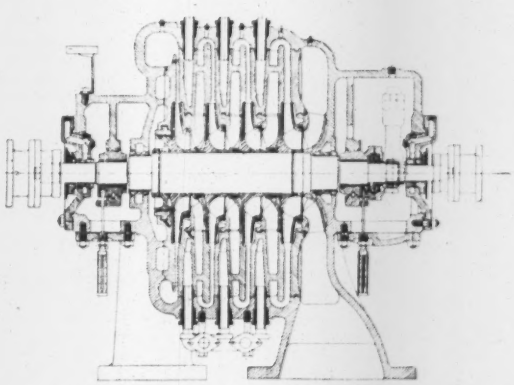
Fatigue machines for alternately stressing fittings, machine parts, assembled components, welds, bolts, and flanged joints are commonly of four types: direct mechanical stressing, direct hydraulic machines, electronic fatigue machines, and the mechanical oscillator.

Heat Transfer

Heat-Transfer Rates in Centrifugal Compressors and the Effect of Internal Liquid Cooling on Performance, by W. E. Trumpler, Mem. ASME, R. W. Frederick, Jun. ASME, and P. R. Trumpler, Mem. ASME, Clark Brothers Company, Inc., Olean, N. Y. 1949 ASME Annual Meeting paper No. 49—A-93 (mimeographed, to be published in Trans. ASME).

For many applications the advantages resulting from cooling a gas during compression have been clearly established. Usually this cooling is obtained by withdrawing the gas from the machine at one or more intermediate points in the compression and passing it through heat exchangers. The construction of a centrifugal compressor is such that, without much added expense, the gas may be cooled as it flows through the fixed passages. Because of the high velocities in these passages the heat-transfer film coefficients are high. The following questions may well be asked: What is the magnitude of these coefficients? How can one calculate the cooling effect which can be obtained in present commercial designs? What is the effect of such cooling on over-all performance and other economic factors affecting users of centrifugal compressors?

This paper provides limited answers to the foregoing three questions. The answers are limited first in scope, concerning themselves only with one commercial centrifugal design, that manufactured by Clark Brothers Company, and applying the results to a study of only one process condition, namely, com-



SECTION THROUGH TYPICAL CLARK FOUR-STAGE CENTRIFUGAL COMPRESSORS

pression of 7500 cfm air at 68 F and 14.7 psia to 114.7 psia.

A second limitation is inherent in the method. As with most industrial research, the need for results was urgent and the man power limited. It was, therefore not possible to examine critically many of the assumptions on which the theory is based.

Fouling of Marine-Type Heat Exchangers, by H. E. Bethon, Bureau of Ships, Navy Department, Washington, D. C. 1948 Annual Meeting paper No. 48—A-145 (in type, published in full in Trans. ASME, Oct. 1949, page 855).

The paper emphasizes the importance of making due allowance for fouling and cleaning in the initial design of heat exchangers for naval service. It describes briefly the design and construction of marine-type heat exchangers (lubricating-oil and jacket water coolers, steam condensers, steam- and thermal-compression distilling plants and fuel-oil heaters), in addition to various design and operating procedures which affect fouling characteristics.

Properties of Gases

Zero-Pressure Thermodynamic Properties of Carbon Dioxide, by Serge Gratch, Jun. ASME, University of Pennsylvania, Philadelphia, Pa. 1948 ASME Annual Meeting paper No. 48—A-150 (in type, published in full in Trans. ASME, Nov. 1949, page 847).

In this report are presented tables of the principal thermodynamic properties of carbon dioxide along the zero pressure isobar in the range 100 to 5000 deg R at the intervals indicated by the numbers in parentheses as follows: 100(5)130(10)240(20)500(50)1000(100)2000(200)5000. The data have been computed by the methods of quantum statistical mechanics from best available information regarding (*a*) the general physical constants, (*b*) the spectroscopic constants for carbon dioxide, (*c*) the isotopic weights of carbon and oxygen, (*d*) the relevant abundance ratios. The computations were carried out in the University of Pennsylvania Thermodynamics Research Laboratory under Project G-12. Computational accuracy well beyond present physical accuracy has been maintained for practical reasons. It is believed that the tables given herein should supersede all previous ones. Although the estimated uncertainties of the values tabulated are still somewhat larger than those for some of the simpler molecules, they are probably small enough for most engineering applications. The calculated values are in fair agreement with those obtained from calorimetric and acoustic velocity measurements.

Final Report of the Working Subcommittee of the International Joint Committee on Psychrometric Data, by John A. Goff, Mem. ASME, University of Pennsylvania, Philadelphia, Pa. 1948 ASME Annual Meeting paper No. 48—A-151 (in type, published in full in Trans. ASME, Nov. 1949, page 903).

The problem before the International Joint Committee on Psychrometric Data may be regarded as consisting of three parts: (*a*) To obtain information regarding the thermodynamic properties of moist air which can claim general acceptance as standard on the ground that it is thermodynamically consistent within the accuracy of existing knowledge; (*b*) to develop specifications of standard instruments for the practical realization of these properties in the field; (*c*) to recommend standard symbols, terminology, and charts calculated to promote a better understanding of underlying theory in its application to practical problems involving moist air. This report sets forth the recommendations of the Working Subcommittee on part (*a*) of the over-all problem and explains the reasoning on which these recommendations are based.

The Physical Properties of Air With Reference to Meteorological Practice and the Air-Conditioning Engineer, by P. A. Sheppard, Imperial College of Science and Technology, University of London, London, England. 1948 ASME Annual Meeting paper No. 48—A-152 (in type, published in full in Trans. ASME, Nov. 1949, page 915).

The paper summarizes numerical values of physical functions and constants, relating to dry and moist air, of common use in meteorology and of interest to the air conditioning engineer, and definitions and specifications of water vapor in the atmosphere.

Viscosity and Other Physical Properties of Gases and Gas Mixtures, by J. O. Hirschfelder, R. B. Bird, and Ellen L. Spotz, University of Wisconsin, Naval Research Laboratory, Madison, Wis. 1948 ASME Annual Meeting paper No. 48—A-153 (in type, published in full in Trans. ASME, Nov. 1949, page 921).

This paper is of special importance to the engineer because it is perhaps the first attempt to present directly a comprehensive review of the theoretical tools available for the calculation of the thermodynamic properties of gases and gas mixtures at finite, if only moderate pressures. The paper reviews a mass of information collected during the past two decades and shows the extent to which it can be correlated and systematized by means of molecular theory. The paper goes further to outline a new and apparently very successful method of formulating and predicting the viscosity and other transport properties of gases and gas mixtures at sufficiently low pressures. The method is the first significant practical improvement over the relatively crude one developed by Sutherland, and it is almost certain that engineers will find it extremely useful once they come to understand it. The extensive tables which are vital to the paper not only illustrate the method but implement it as well so that the user is enabled to calculate the viscosity and other transport properties of a large class of technically important gases and gas mixtures with very little labor.

Experimental Determination of Heat Conductivity for Gases, by F. G. Keyes, Massachusetts Institute of Technology, Cambridge, Mass. 1948 ASME Annual Meeting paper No. 48—A-154 (in type, published in Trans. ASME, Nov. 1949, page 939).

This paper is an abstract of a presentation of the experimental methods and results obtained to December 1, 1948.

Applied Mechanics

Compliance of Elastic Bodies in Contact, by R. D. Mindlin, Mem. ASME, Columbia University, New York, N. Y. 1948 Applied Mechanics Division Conference paper No. 48—APM-24 (in type, published in full in the *Journal of Applied Mechanics*, Sept., 1949, page 259).

A small tangential force and a small torsional couple are applied across the elliptic contact surface of a pair of elastic bodies which have been pressed together. If there is no slip at the contact surface, considerations of symmetry and continuity lead to the conclusion that there is no change in the normal component of traction across the surface and, aside from warping of the surface, there is no relative displacement of points on the contact surface. The problem is thus reduced to a "problem of the plane" in which the tangential displacements and normal component of traction are given over part of the boundary and the three components of traction are given over the remainder. In the case of the tangential force it is observed that, when Poisson's ratio is zero, the problem is a simple one,

in potential theory, which is then generalized by means of a special device. An expression for tangential compliance is found as a linear combination of complete elliptic integrals. In general, the compliance is greater in the direction of the major axis of the elliptic contact surface than in the direction of the minor axis. Both components of tangential compliance increase as Poisson's ratio decreases and become equal when Poisson's ratio is zero. Over the practical range of Poisson's ratio, the tangential compliance is greater than the normal compliance, but never more than twice as great as long as there is no slip. The tangential traction on the contact surface is everywhere parallel to the applied force. Contours of constant traction are ellipses homothetic with the elliptic boundary. The magnitude of the traction rises from one half the average at the center of the contact surface to infinity at the edge. Due to this infinity, there will be slip, the effect of which is studied for the circular contact surface.

Fluid Meters

Calibration of Eccentric and Segmental Orifices in 4- and 6-in. Pipe Lines, by S. R. Beitler, Mem. ASME, and D. J. Masson, Jun. ASME, The Ohio State University, Columbus, Ohio. 1948 ASME Annual Meeting paper No. **48—A-149** (in type, published in full in Trans. ASME, Oct. 1949, page 751).

This is a preliminary report of a Subcommittee on Eccentric and Segmental Orifices of the Special Research Committee on Fluid Meters on the Calibration of Eccentric and Segmental Orifices. It describes the method used in calibrating orifices in 4 and 6-in. pipe lines and gives the results of the calibration which are available at this time. This program is in its early stage only and as a result, about 50 per cent of the work has been done.

Critical Flow Through Sharp-Edged Orifices, by J. A. Perry, Jr., Jun. ASME, Illinois Institute of Technology, Chicago, Ill. 1948 ASME Annual Meeting paper No. **48—A-146** (in type; published in full in Trans. ASME, Oct. 1949, page 737).

An investigation was made to discover the flow rates of air through sharp-edged orifices in which the pressure drop was below the critical, the relationship of pressure, temperature, and orifice area; and a comparison between the nozzle and the orifice. Equations are derived for expressing orifice flow in both the critical and subcritical regions.

Gas-Turbine Power

Current Design Practices for Gas-Turbine Power Elements, by H. D. Emmert, Mem. ASME, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. 1948 ASME Annual Meeting paper No. **48—A-170** (in type, published in full in Trans. ASME, Feb. 1950, page 189).

A brief description is presented of certain principles of design and analysis for power elements of commercial gas-turbine plants. These principles are based upon the experience of the gas-turbine engineering group of the author's company. The discussion comprises a review of procedures for analysis of turbine performance and design of blading and blade-carrying elements. Since the mechanical reliability and useful service life of a gas-turbine plant are governed almost entirely by the design of the power element, such a design must be a compromise between requirements for high efficiency, dependability, and low first cost. The fulfillment of these requirements is assisted by the organization of fundamental principles and experience into basic design practices.

Metals Engineering

Bending of an Ideal Plastic Metal, by J. D. Lubahn, Jun. ASME, General Electric Company, Schenectady, N. Y., and G. Sachs, Mem. ASME, Metals Research Associates, Inc., Cleveland, Ohio. 1948 ASME Annual Meeting paper No. **48—A-168** (in type; published in full in Trans. ASME, Feb. 1950, page 201).

The stresses and strains in plastically bent parts have been analyzed for the two limiting conditions of (*a*) a very wide plate (plane strain), and (*b*) a very narrow bar (plane stress). The complete solution is presented for a hypothetical metal with no strain-hardening, and the method is described for treating any actual metal. The solution was obtained by a method of successive approximations, each approximation employing various graphical processes. The gradual change in cross-sectional contour with progressive bending was obtained by considering small successive intervals of increasing curvature. The final solution shows the movement of the neutral axis toward the compression surface, the decrease in the radial dimension of the part, and the gradual divergence between the tangential strains at the inside and outside surfaces. The solutions for plane stress and plane strain were nearly identical as regards the tangential strains and the changes in the radial dimension. Experimental measurements of surface strains and cross-sectional contour of bends conformed well with the results of the calculations.

ASME Transactions for March, 1950

THE March, 1950, issue of the Transactions of the ASME, which is the *Journal of Applied Mechanics*, contains the following:

TECHNICAL PAPERS

Transverse Vibration of a Two-Span Beam Under Action of a Moving Constant Force, by R. S. Ayre, George Ford, and L. S. Jacobsen. (49—SA-4)

Beam-Vibration Analysis With the Electric-Analog Computer, by G. D. McCann and R. H. MacNeal. (49—SA-3)

The Behavior of Long Beams Under Impact Loading, by P. E. Duwez, D. S. Clark, and H. F. Bohnenblust. (49—SA-1)

The Effect of an Axial Force on the Vibration of Hinged Bars, by S. Woinowsky-Krieger. (49—APM-2)

Graphical, Mechanical, and Electrical Aids for Compressible Fluid Flow, by H. Poritsky, B. E. Sells, and C. E. Danforth. (49—APM-24)

Introduction to the Comprex, by F. W. Barry. (49—APM-18)

Use of an Optical Property of Glycerine-Water Solutions to Study Viscous Fluid-Flow Problems, by W. W. Haggerty. (49—APM-21)

Holzer Method for Forced-Damped Torsional Vibrations, by T. W. Spaetgens. (49—APM-12)

A Comparative Study of Some Variational Principles in the Theory of Plasticity, by Rodney Hill. (49—APM-16)

Deflections and Moments Due to a Concentrated Load on a Cantilever Plate of Infinite Length, by T. J. Jaramillo. (49—APM-15)

Effect of Imperfections on Buckling of Thin Cylinders and Columns Under Axial Compression, by L. H. Donnell and C. C. Wan. (49—APM-14)

On Plastic Flow and Vibrations, by C. J. Thorne. (49—APM-23)

Flow of Heated Gases, by A. S. Thompson. (48—A-45)

DISCUSSION

On Previously Published Papers by H. D. Conway; M. S. Plesset; B. E. Quinn; F. E. Reed; L. F. Coffin, Jr., P. R. Shepler, and G. S. Cherniak; E. Sternberg and M. A. Sadowsky; H. L. Langhaar; and J. B. Woodson.

BOOK REVIEWS

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Employee and Community Relations

COMMENT BY REYNOLD ATLAS[1]

When the author in commenting on the subject of employee and community relations[2] stated: "Our men are most interested in three things, job security, wages, and opportunity for advancement," he left out one element which comes before any of those three. As long as a minimum wage is paid, as is now generally assured by unions, government regulations, and the labor market, employees want something else from their work. The principal goal to most people is that of getting satisfaction from their work, in doing a useful job, in accomplishing something worth-while through their efforts. People get no satisfaction from idleness, from effort that they feel is a waste of time, from lack of tools, equipment, or supplies which prevents them from "getting their job done." People take pride in their work and want to do a good job. Management can increase production greatly by appealing to this motive.

Artisans who have specialty trades are excellent examples of individuals who are interested in doing useful work and doing it well. Generally they are attracted to a particular trade, so that their production and the quality of their work depend directly upon their liking for it. Although there are many individual exceptions, giving a person more useful work and more pride in his work will increase his production far more than an increase in pay. Much experience by enlightened management bears this out.

COMMENT BY RABBI RANDALL M. FALK[3]

As a minister, I have been profoundly impressed by the depth of understanding of human needs and human aspirations which permeate this paper. There are spiritual values in our material "tug of war," and it is always encouraging to note that basic ethical and moral principles by which men should live have not been confined to the orator's platform or the minister's pulpit. For if these principles are to have significance in man's daily life, they must be practiced in man's relationship with his fellow man in our homes and factories, in our communities and in the nations of the world. I therefore heartily concur in the philosophy which should govern employee and community relations, as outlined by the author.

Though there are no points on which I would take issue with the author, there are two additional statements which I feel should be made in discussing "employee relations." If management truly seeks to deal justly with each employee, it seems to me that there is an essential obligation to help every man find the right job—a job in which the individual may develop his potentialities to the maximum, so that he is neither discontented by the limitations of his position nor overburdened by a task that is beyond his abilities. Vocational adjustment is as essential as is social adjustment in keeping men satisfied in their work; even more important is the fact that a man who is well adjusted to his job, is a man who will be a better father for his children, a better citizen in his community. Great strides have already been made in this field through trained personnel counselors—there is still much to be done.

In our approach to the unions, I feel that it is important to keep in mind that all unions are not hotbeds of communism, and the vast majority of their membership does not have communistic tendencies. It is unfair to the American workingmen to be branded, as they have been by so many, as being left-wingers and fellow travelers, if not actually communists. The American workingman is still the backbone of our nation. If he is influenced by certain radicals at work in his union, then our responsibility is to counteract such influence by correct interpretation of the tenets of Democracy in our dealings with him. If democratic principles are truly practiced in the relationship between employer and employee, then no foreign "ism" will be able to compete with our Democracy for the loyalty of our workingmen.

Regarding "community" relationships," may I suggest that management has a very important obligation to manifest a serious interest in the health facilities, the educational opportunities, the cultural advantages, the housing and general living conditions in the cities in which the workers reside. No man can long be satisfied in a city which does not provide adequately for the needs of his family. We need not be paternalistic in assuming leadership in securing good government and adequate social welfare facilities on the community level, in order to maintain decent standards of living for all employees.

COMMENT BY EDWARD C. DOLL[4]

The writer has had almost thirteen years' experience dealing with labor unions, and much longer than this in the matter of community relations of employees.

The writer's experience has been in a small plant having approximately 600 employees. Like the author, there is probably nothing original in his observations. Certainly there is agreement with the author in seeking the goal of "spontaneous co-operation" through the steps of justice to each employee, favorable attitude toward trade unions, and informing and educating employees adequately.

Justice appears to be a simple principle. In a small plant this is mellowed with sincerity, warmth, and even a form of brotherhood. The various techniques outlined by the author such as job security, wages, opportunity for advancement are necessary and operate in a small plant, although not on as highly developed a scale.

The need for some type of employee organization is evident, for certainly we all recognize that, in years gone by, there has been some exploitation of labor. The union seems to be the best medium, but where difficulty arises is the influence of national officers and policies. In the writer's opinion, the author eliminates this factor too easily.

"Should we confuse the principle of unionism with bad union leadership?" The writer would answer this question

[1] Major, U. S. A.; Benicia Arsenal, Benicia, Calif. Mem. ASME.

[2] "Employee and Community Relations," by H. L. R. Emmet, MECHANICAL ENGINEERING, vol. 71, November, 1949, pp. 925–928.

[3] Anshe Hesed Temple, Erie, Pa.

[4] President, Lovell Manufacturing Company, Erie, Pa.

by asking another: "Can we by the very political nature of the movement divorce the two?" The answer to this second question has a strong bearing on the author's third recommendation, namely, properly informing and educating employees. Because of bad leadership and the political nature of the movement, we have something like an iron curtain. The following quotation is from a statement made by Mr. Dallas, chairman of the board, Revere Copper & Brass, Inc.:

"The iron curtain is one of prejudice built up by incumbents of political and union jobs. Public offices are likely to go to the demagogues who promise anything or everything likely to win a vote. Union offices often go to the men who campaign on platforms of ever more pay and less work."

Unfortunately, leaders are paid to keep men discontented, for if they were loyal and happy, there would be no need for outside pressure.

In addition to the difficulties from the factors mentioned, we face internal problems also. The most important of these is ignorance on the part of so many employees. How can they be expected to understand depreciation, taxes, dividends, and the like. Also, we have always with us the influence of the radical fringe—perpetual gripers. These conditions can only be remedied by improving the quality of personnel. Furthermore, people of all strata of intelligence believe what they want to believe and, of course, our employees are bombarded by vicious propaganda from the labor press. Despite all this, the effort must be made, and the spoken word is certainly the best.

In conclusion, justice seems to be the easiest goal to achieve, dealing with the union the toughest because of politics and bad leadership. Human nature is so perverse that reasonableness on the part of union leadership often leads to discrediting and accusing employees of being "company men." The most important factor by far is education, which; if successful, ultimately will overcome most of today's troubles.

Progress has been made. Plants here and there have been successful in their labor relations, and most plants have had satisfactory experience during the war through bond drives, production drives, community-chest campaigns, etc.

In the last analysis, we as management must make an intelligent and aggressive effort to educate our employees, or take the consequences.

AUTHOR'S CLOSURE

Rabbi Falk accentuates two supremely important considerations. I can gladly agree that managements must not hesitate to incur substantial effort and expense in recording, through individual rating techniques, the effectiveness of each individual on his job, at the same time recording his versatility, prior experience, and so on, so that every possible opportunity be given him to achieve a job which he is best suited to.

If possible, a comprehensive apprentice school should be provided for prospective younger employees as well as night-school facilities for any employees who wish to enroll. We should perhaps remember that existing featuring of seniority practices often proves helpful to individuals in discovering new and more congenial jobs. Personnel counseling is indeed becoming recognized as an essential activity in American industry and I believe it to be a highly advisable development.

I suppose it is one of the glories of our nation that in many of our industrial cities a true slum can no longer be found. Perhaps the day is not far distant when such a condition will be universal in the United States. Our industries have had much to do with this state of affairs—often involuntarily perhaps, but for the most part by their earnest and enlightened co-operation and leadership. May we persevere toward this great goal with increasing interest, effort, and intelligence. Here again, there is still much to be done.

Major Atlas's comment is most appropriate. Of course, workers want job satisfaction more than most things. I have an impression that in the shop where spontaneous co-operation is high, job satisfaction will likewise be high.

In our great modern mass-production shops every operation is so highly simplified that the learning time required in the vast majority of shops amounts to a very short period indeed. This results in a condition where there is little opportunity for true craftsmanship on the part of nearly all production workers. Of course, there will always be required a small group of highly skilled mechanics who have devoted many years to learning their trade. It is among these few that we will always find the greatest opportunity for true pride of craftsmanship and job satisfaction.

For the vast majority of workers, I believe we are making headway toward developing avenues of job satisfaction which are very real. Some of these are mentioned in my paper. It appears that for these great numbers of semiskilled and unskilled workers spontaneous co-operation on their part is a pretty trustworthy indication of both job pride and satisfaction.

My old friend, Ed Doll, as is his most proper practice, has not hesitated to face up to a number of the most difficult facts of this Union business in which we are, I suppose, relatively inexperienced and smarting from many bitter and often very outrageous experiences.

When our fathers in management sat on a too monopolistic "driver's seat" it may be that they indulged in about the same kind of excesses that we now charge against so many in Union leadership who presently seem to sit in the current driver's seat in what appears to be a most monopolistic and arbitrary fashion.

History seems to teach us that at long last laws must be provided by a free people to regulate such excesses and to protect themselves from them. As suggested in my paper, I believe that such a process is now in progress.

As seems to be the case with sociological processes of such a nature, progress is slow, painful, and fraught with a good deal of injustice to many people. However, such seems to be the invariable price of progress in such matters among us humans as the generations of us live and strive for something better.

H. L. R. EMMET.[5]

[5] Erie, Pa. Mem. ASME.

Coal-Handling Systems for Locomotives

COMMENT BY E. J. BOER,[6] AND J. H. STANG[7]

We agree with the author[8] that the development of the locomotive stoker has been a principal factor contributing to the building of large, powerful steam locomotives currently in use. As a matter of interest, reference to this idea has been made by J. P. Baumgartner.[9] By assuming a maximum average continuous rate of 55–66 lb per min for manual firing, the conclusion is made that, if the grate area of a typical European locomotive exceeds 54 sq ft, it is necessary to employ a me-

[6] Assistant Supervisor, Battelle Memorial Institute, Columbus, Ohio. Jun. ASME.

[7] Research Engineer, Battelle Memorial Institute. Jun. ASME.

[8] "Coal-Handling Systems for Locomotives, Past, Present, and Future," by J. J. Kane, MECHANICAL ENGINEERING, vol. 71, December, 1949, pp. 1011–1016.

[9] "On the Installation of Mechanical Stokers in European Steam Locomotives," by J. P. Baumgartner, *Engineers Digest* (American Edition), vol. 4, 1947, pp. 102–103.

chanical stoker to sustain maximum locomotive capacity.

Stokers applied to current high-speed road locomotives must distribute the coal fired into a mass of high-velocity firebox gases. The upward velocities of the gases immediately above the grate may exceed 1700 fpm, while those passing the tip of the arch may be 5–6 times as great. This, of course, offers a barrier to satisfactory horizontal travel of the coal particles to insure that all areas of the grate will be reached. A deficiency in the supply of coal to a particular area will result quickly in thinning of the bed in that area. This, in turn, will allow excessive air flow through the thin part and decrease the flow through the remaining area of the bed. Decreased rates of burning and, under certain conditions of operation, steam failures will result from this chain of events. Although the present arrangement of the distributing plate and jets is a simple means for achieving satisfactory fuel distribution, maintaining a good fuel bed is an art which all firemen have not learned.

However, the present locomotive stoker possesses a disadvantage inherent to the coal-delivery system, namely, that of degradation of coal in the conveyer screw. The fine coal created by the action of the screw in its housing undoubtedly increases carry-over which is the principal loss of fuel from steam locomotives. The increase is inevitable because a greater percentage of the total coal fired will be suspended in the high-velocity gas stream in the firebox, carried into the flues, and, consequently, discharged, practically unburned, out of the stack. The application of a belt-conveyer system from the hopper to the firebox to minimize this disadvantage has received considerable thought although, to the writers' knowledge, actual experimental work to advance this system has not been done.

Heavy-Duty Bearings

COMMENT BY J. A. FAVRE[10]

While the unique advantages of textolite bearings in switchgear have been recognized for the past seven or eight years, the lack of published information on the subject has been caused in part by the difficulty in explaining all of the phenomena observed. In addition to correlating the data already collected, the author[11] has given the subject a more scientific treatment and provided a better record for the guidance of those unfamiliar with established practice.

It should be emphasized that textolite bearings are in no sense so-called oilless bearings. Their behavior is quite in line with earlier observations and present-day theories of boundary lubrication which is notoriously marginal. Close observation of all the details of successful practice is necessary to avoid failure. Five factors influence results, and any one can cause failure. With boundary lubrication, the nature of the lubricant is usually listed first in importance, then finish, then material of rubbing surfaces, lubricant supply, and temperature.

With grease as a lubricant, the addition of graphite to the plastic resin shows no benefits, and metaloid additives actually have increased friction.

A limited amount of lubricant is absorbed by the fabric in close proximity to the journal which is, of course, beneficial as storage. Curves given in Fig. 13 of the paper, indicate that maximum results are attained when this inner surface is under some compression. This reduces the amount absorbed to an even smaller quantity than normal. This small quantity, however, is sufficient for long service.

Lubrication theory advances the claim that a lubricant with sufficient oiliness need produce an adherent film only 1 molecule in thickness for satisfactory service. One author describes the arrangement of molecules as like the stalks in a field of wheat rooted in the ground. The thickness of such a film on a $\frac{1}{2}$-in. ball is about in the same proportion as the height of the wheat is to the diameter of the earth. Marked differences in results with different lubricants seem to support this theory that strong molecular lateral attraction and attachment are necessary for persistence of oiliness and adherence of films capable of supporting these loads, even after months of static loading.

Considering the fact that phenolic plastics are abrasive when dry and the limited motion and lubricant supply, common to switchgear-bearing practice, preclude any benefit from a fluid wedge, their success as bearing material is quite as astonishing as their benefits are real.

AUTHOR'S CLOSURE

Mr. Favre mentions five factors which influence boundary lubrication. This paper deals principally with the factor concerning the choice of materials although the other four closely affected this undertaking. Textolite with stainless-steel pins gave the lowest coefficient of friction under heavy loading of all materials investigated. Reference to so-called oilless bearings focuses attention on the fact that this type of bearing was tried without success. It lacked the ability to withstand the shock encountered in circuit-breaker operation.

Storage of lubricant is accomplished not only by the slight amount absorbed by the fabric, but probably to a much larger extent by the "pits" on the surface of the bearing. Microscopic examination of this surface reveals that the uneven surface caused by the weave of the cloth is not entirely filled with resin, leaving a scattering of "pits" that will retain lubricant.

While low coefficient of friction with heavily loaded bearings, having intermittent oscillatory motion, is of utmost importance in circuit-breaker operation, the high resilience of textolite contributes largely to its success as a bearing.

R. R. BUSH[12]

[10] Engineering Section, Air Circuit Breaker Division, Switchgear Divisions, General Electric Company, Philadelphia, Pa.

[11] "Heavy-Duty Bearings With Intermittent Oscillatory Motion," by R. R. Bush, MECHANICAL ENGINEERING, vol. 71, November, 1949, pp. 911–916.

[12] Development Engineer, Switchgear Division, General Electric Company, Philadelphia, Pa. Mem. ASME.

Office Machines

COMMENT BY WILLIAM F. BERCK[13]

It is recognized that the author[14] has stressed particularly the design of complicated mechanisms, almost dainty in their construction and produced by mass-production techniques, but there is a considerable benefit to be derived from his remarks to those who must develop complex mechanisms of more rugged design and of limited production. It would seem well in this discussion also to include that type of design work.

Although punch presses and screw machines are well-recognized tools of economical mass production, it would probably not be amiss to add that, if design from its inception also encompasses the production possibilities of die castings, sintered products, microcast parts and various automatic machining

[13] Chief Engineer, Ralph N. Brodie Company, Oakland, Calif.

[14] "The Design of Office Machines—Such as Calculators," by H. T. Avery, MECHANICAL ENGINEERING, vol. 71, September, 1949, pp. 719–724.

processes, economies may be effected by combining parts and functions in one piece which in other processes might require the fabrication and assembly of several pieces.

By releasing the designer from strict adherence to certain production processes and allowing him to seek the benefit of other manufacturing techniques, his work very often is simplified. Since design, even of an experimental machine, is greatly concerned with production, the possibilities of saving the designer's time by unfettering his production thoughts is considerable. Also it is not too unusual that a radically new development cannot even be considered until new production tools have been developed. The design engineer has ever caused the production engineer to reach beyond present limitations; this is progress for both.

The author touched briefly on one topic which is of sufficient importance to warrant extensive discussion, but which very often is neglected, and many times goes unrecognized, namely, the "cumulative effect of tolerance variations." Usually it will be necessary to train a designer in the technique of this type of work. Ability to diagnose tolerances and operating conditions correctly is an exacting art which must be acquired. Needless to say, all layouts of tolerance factors should be preserved carefully against the coming problems of production. In cases of extreme variations of mating assemblies, working sections representing minimum and maximum of tolerances are timesaving and final.

In reference to the remarks on "design procedure," it should be noted that probably the highest development of kinematics is embodied in today's office machines, especially those of calculating-machine structure. Our technical schools would do well to encourage recognized engineers in this and allied fields to contribute to their reference libraries and textbooks. In particular it has been the good fortune of the writer to observe the author's methods of analyzing complicated mechanical motions; these methods are quite often unorthodox but achieve accurate results with a minimum expenditure of time. They involve the use of novel shortcuts and empirical work to eliminate tedious mathematics. In the original study of a design, delays in analyzing the mechanical motions involved often result in the expenditure of many valuable manhours not only in design but in the making of experimental parts. Amplification of the few remarks on this treatment of design problems is very desirable.

Under the heading "Releasing Design for Production," several points are suggested for detailed consideration:

1 Unless a close and co-operative association is formed between production design personnel and development engineers, a great lapse of time may result between experimental models and actual production. Also, the development engineer should keep an historical record of his work, noting and stressing those points which will be most critical in production. This information so easily can be lost and neglected in the inevitable compromises resulting from reduction of experiment to practicality.

2 Parts lists and usages are of primary importance as only by this means can coherent production be established. Too often this essential work is relegated to individuals who have neither knowledge nor capacity. Of the many parts-list systems in use, all have some shortcomings, but most will serve this purpose excellently if they are accurate and consistent. Here, if ever, consistency is a virtue. For that reason individual development engineers should not be allowed to furnish anything but a requirement list. The work of correlating the lists should be assigned to specially trained and capable individuals who ideally should have no other duties.

3 Development engineers, the people best fitted to initiate key personnel into the mysteries of a new product, are often considered by management to be too valuable to use in this service. Consequently, over a period of many months, the design engineering department is besieged with simple questions stemming from the embarrassing ignorance of people in responsible positions in production. Industry decries the lack of intelligence and perspective in key employees and yet is often unwilling to take remedial steps. Let management use trained engineering personnel for the dissemination of pertinent facts on strange new products.

The over-all presentation of this type of design work is one which will naturally raise the questions of where to obtain or how to train design engineers for this extremely intricate work, and after training, how to keep them. It is hardly possibly to separate the mechanics of a design problem from the individual struggling with that problem; therefore it would seem that this topic should not be closed without some reference to the designer, his incentives, his working conditions, and his tools. So often this man, a creative thinker and doer, is considered a means to an end—an idea factory. Usually, he is not as temperamental as creative minds in other arts and, perhaps, because of this, he often is the least rewarded of individuals in relation to his contributions. It would seem that gradually the designer is being relegated to the same class as an untrained repetitive worker. The necessity for a change of this attitude is indicated by the dearth of high-quality men. The position of supremacy of manufactured products which we enjoy today is due in no small part to the development engineer; for this and many other reasons this discussion should end on a high note of regard for the efforts of these individuals.

COMMENT BY J. S. BIGGS[18]

The calculator described in this paper is an instrument of special interest since it gives the results of a calculation to zero tolerance in spite of the fact that it is composed of hundreds of parts. Each one of these parts has been designed in such a manner that it may have tolerances wide enough to enable the part to be produced economically by mass-production methods and yet not affect the over-all accuracy of the instrument.

The mention of automatic gear shifters, nine-speed transmissions, planetary speed reductions and differentials reminds one of automotive practice. These examples clearly show the wide application of the fundamental building blocks of mechanism.

One of our senior classes has been studying the design and operation of these calculators. They were greatly impressed by the ingenuity of the carry-over mechanism and the method of backing off the fractional digital steps at the end of the calculation.

Reading between the lines of the paper, one sees a picture of an even more interesting "machine," a smoothly running engineering department. The recognition of the need for a product by a wide-awake sales organization, backed up by extensive market research to determine quantity and price, provided the engineers with a solid economic foundation upon which to base their design and tooling. Close co-operation between design and production engineers in the very early stages of design help to reduce engineering costs, avoid last minute compromises, and save time lost in redesigning to suit available production facilities. The building of working models for study by the development engineer is also excellent practice, in helping to remove the "bugs" in the design before expensive tooling is under way. We understand that the styling of these

[18] Assistant Professor of Engineering, University of California, Los Angeles, Calif.

machines was done in the engineering department. This is another decided advantage, when the industrial design can proceed along with the functional design rather than the practice of calling in an outsider to "dress up" a product after the functional design is completed.

AUTHOR'S CLOSURE

By adding well-chosen information and emphasis, Mr. Berck's comments provide an excellent supplement to the author's article.

Mr. Berck does well to call attention to die castings, sintered products, microcast parts, and automatically machined parts as supplementing punch-press and screw-machine parts. Die castings are undoubtedly more extensively used in office machines than the other items on this supplementary list. Die castings made of alloys of zinc, aluminum, or magnesium are frequently used for covers and casings and occasionally for frames, but relatively seldom for primary working parts in the best modern office machinery.

Sintered parts made from powdered metals have been used principally in oil-impregnated bearings. The sintering process tends to cause dimensional changes which usually require burnishing, broaching, grinding, or other machine operations in order to bring the part up to the dimensional accuracy usually demanded of office machine parts. This renders it more difficult to economically justify the sintered parts, but it is probable that more extensive search for possibilities in using such parts would appreciably increase their use, and such searches are in progress.

Microcast parts or investment castings are seldom justified on high-production office machinery. On the other hand, high production distinctly indicates the desirability of increasing the use of automatic machining processes and automatic cycling of many machine tools and of other production equipment.

It is believed that the computation of the extreme effect and of the probable cumulative effect of tolerance variations is not as difficult as it is painstaking, but it is frequently overlooked. Where a great many pieces made of flat stock are assembled on one shaft, it is frequently impossible to hold the maximum possible build-up of tolerances within required limits. One method for taking care of such a situation, particularly where the parts consist of ordinal groups of say ten or fifteen parts each, is to compensate for build-up of tolerances by separating each such group of parts by a selective length spacer. After each ordinal group of parts has been assembled, an indicator may be used to measure the height of the last part assembled, which indicator may be graduated to indicate by its reading whether a long, short, or medium spacer is required to substantially compensate for the total build-up of tolerances to the point of question. In general, the accumulative effect of tolerance variations is less serious today than a few years ago, because production engineers are finding better and cheaper ways of manufacturing to closer limits.

Any adequate amplification of the treatment of design problems runs into space requirements far beyond that possible in these remarks.

The author certainly agrees with Mr. Berck in his emphasis on the importance of maintaining accurate and consistent parts lists. Such lists are the foundation from which the fundamental controls in a factory setup are derived. In the production of office machines where thousands of parts are involved in a single machine, this is a very important consideration. Capable individuals who specialize in the correlating of parts lists are a great asset to any office-machinery engineering division.

Both Mr. Berck and Professor Beggs pay well-deserved tribute to the engineers who function as creative organizations to make possible the economical production of complicated, high-performance machines.

HAROLD T. AVERY.[16]

[16] Chief Engineer, Marchant Calculating Machine Company, Oakland, California.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Backgrounds of Power

BACKGROUNDS OF POWER. The Human Story of Mass Production. By Roger Burlingame. Charles Scribner's Sons, New York, N. Y., Charles Scribner's Sons, Ltd., London, England, 1949. Cloth, 6 × 9¼ in., Bibliography, x and 372 pp., $5.

REVIEWED BY LILLIAN M. GILBRETH[1]

THIS is an interesting book. Its author was born in New York and educated at Harvard. After two years of mechanical engineering, at college, he turned toward a literary career. He has written much, in a diversity of fields. Two previous well-known books in the vein of the one being reviewed, "March of the Iron Men," 1938, and "Engines of Democracy," 1940, are described by their publishers as "on the social history of American ingenuity." As the subtitle indicates, this new book is in the same category.

To appreciate the book properly, an engineer-reader might well start by reading the book backward. First the fine index, next a most stimulating bibliography, then the last chapter, etc. Reading it in the usual way, the engineer is put on the defensive by the early chapters which seem to imply if not to state that the effect of technological progress on human beings has been bad.

Such statements as are made in the early chapters, critical and even at times denunciatory, of technical men, lead the engineer to question every argument, to resist rather than to go along with the author. He finds small inaccuracies, generalities, lack of understanding of the relation of technology to science, and is tempted to leave the rest of the book unread.

This would be a mistake, for the book increases in interest, significance, and power as it goes on. One finds much to enjoy, the discriminating praise of such clear thinkers and writers and fine people as Professor Joseph W. Roe and Dr. Siegfried Giedion; valid evaluation of both President Hoover and President Roosevelt; an understanding of "rationalization" in Germany that is rare, and many other things.

Feeling as he may that the author had

[1] President, Gilbreth, Inc., Montclair, N. J. Fellow ASME.

too little engineering at college and has followed engineering with too little sympathy and understanding since then, the engineer-reader must concede that he has a fine grasp of social problems and on the needs of the individual. The need for recognition, the need for individual importance, the need for participation—all so beautifully and simply brought out in David Lilienthal's "This I Do Believe," and in other books like Dr. William Menninger's "You and Psychiatry" and Pearl Franklin Clark's "The Challenge of the American Know How"—all these our author recognizes and states.

The engineer should read and will enjoy this book, once he subdues his natural resistance to some of its implications, and especially if he recognizes an opportunity to find out what a nontechnical writer, writing for nontechnical readers thinks of him. More than this, he will finish the book with a new pride in the achievements of his predecessors, a new realization of why the present-day emphasis on the human element is important and a new challenge to use science and technology constructively.

A list of chapter titles may illustrate some of the points made: 1 Machines, Men and History. 2 Origins. 3 Prime Movers. 4 Assumption of Skill. 5 Division and Unity. 6 Speed and Integration. 7 Cultural Levels. 8 Yankee Directions. 9 World's Fair. 10 Mass War. 11 Mass Finance. 12 Steel. 13 The Labor Jelly. 14 Backwash. 15 The Ford Revolution. 16 Mass World. 17 Resistances.

Historic Researches

Historic Researches: Chapters in the History of Physical and Chemical Discovery. Morgan Brothers, Ltd., London, England, 1949. Cloth, 7 × 9¾ in., iv and 288 pp., 85 figs., 21/-net.

Reviewed by L. W. McKeehan[2]

THESE twelve chapters reprinted from the London *Engineer* appeared at intervals throughout four years and show a considerable variation in content and method of treatment. They all, however, succeed very well in conveying the history of the development of selected ideas in physics, chemistry, and engineering up to the time when the selected subject emerged into its modern phase. These emergences, of course, occurred at widely different times.

This book is a very successful antidote to the oversimplification in the usual text book, which is inclined to attribute all the advances up to a given period to the individual who then made the general statement now remembered. Perhaps the best example of this situation presented here is in Chapter 10 on the "Conduction of Electricity Through Gases," culminating in the determination of the electronic charge.

As collateral reading for a specialist the book has much to recommend it but the general reader may get the feeling that science progresses only through a fog. Some slips in the author's command of his numerous subjects may be indicated. A magnetic dipole and a loop of current are not equivalent as to field except at great distances. There is no single fundamental discrete quantity (quantum) in terms of which a body exchanges energy with others, since every body has more than one choice. The most recent names of elements numbers 43 and 95 are technetium and americium (not masurium, americanium). The impression raised on pages 136 and 137 that the rare earth metals still defy classification in the periodic table is certainly incorrect. A curious blunder on page 224 is the statement that the ionization of a gas by x rays makes it opaque to x radiation and limits the maximum ionization which can be reached. It is, of course, the recombination of ions which is responsible for this limitation. The statement on page 257 that probably every element is of the "multiple" kind, with more than one stable isotope, with the possible exception of gold and of some rare earth elements, ignores the most familiar examples: beryllium, fluorine, sodium, aluminum, phosphorus.

The last twenty pages consist of biographical notes concerning thirty-four worthies mentioned in the text. The information given is in many cases extremely difficult to find elsewhere and the author is to be commended upon detaching these notes for easy reference in order to keep his main text more continuously on the researches performed. While everyone will not agree with the opinions of Mr. Chalmers regarding some of his biographees, the facts listed appear to be correct and even the most adverse opinions have previously been supported by other authors.

The binding and paper are of very good quality, the margins are wide, and the book will be a pleasing addition to any technical library.

[2] Director, Sloane Physics Laboratory, Yale University, New Haven, Conn.

The Market for College Graduates

The Market for College Graduates: And Related Aspects of Education and Income. By Seymour E. Harris. Harvard University Press, Cambridge, Mass., 1949. Cloth, 5½ × 8¼ in., xiv and 207 pp., 49 tables, 31 charts, notes, $4.

Reviewed by D. B. Prentice[3]

THE book, "The Market for College Graduates" is a discussion and a warning by a member of the Harvard Committees on General Education and Educational Policy and the author of "How Shall We Pay for Education." It should be required reading for all educators and especially members of college and professional-school faculties. Parents who are professionals themselves or who have professional ambitions for their sons and daughters should study the tables and conclusions of Mr. Harris, for the sake of learning the negative even if they act on the affirmative. Parents may conclude that professional opportunities will always exist for the cream of the graduate school crop and that their youngsters are pure cream (not thick cream, to make an unpardonable pun). But according to Mr. Harris the expansion of higher education and the encouragement of hopes for professional careers are leading to many bitter disappointments in the years ahead and may produce a disillusioned group of socially and intellectually maladjusted citizens. As the author states in his Recapitulation: "My main purpose is to show that a large proportion of the potential college students within the next twenty years are doomed to disappointment after graduation, as the number of coveted openings will be substantially less than the numbers seeking them."

And again, "Should the recommendations of the President's Commission be adopted (for expansion of college enrollments) the market for graduates will soon be saturated, and there will be saturation on more modest assumptions. With an enrollment of 4.6 million college students, as proposed by the Commission, by 1968 severe excesses of graduates will have developed in the proprietor-managerial occupations while professional openings will be scarcely one half of those required. The President's Commission deals vigorously with the problem of supply and demand, but is altogether too optimistic."

[3] Director, Scientific Research Society of America, New Haven, Conn. Fellow ASME.

The relative economic status of the college graduate already shows the effects of oversupply. "Even since 1940, the college graduate's income has risen only about 60 to 75 per cent as much as that of the population generally." College training *per se* may offer its own rewards in appreciation of life and understanding of its problems, but in the author's opinion, "Millions of college graduates who are confronted with deciding between, for example, a teaching post at $1500 (1947 dollars), a law practice at $1200, or an unskilled laborer's job at $3500, will experience a keen sense of disappointment and frustration." This reviewer is quite willing to agree with that statement, which may be an understatement, for disappointment and frustration are mild terms.

The organization of material in this volume is unique and has decided advantages. An introductory section explains to the reader that Part 1 presents the essential analyses and conclusions with a minimum of statistics. (Part 1 covers 75 pages.) Part 2 (with 120 pages) gives detailed analysis and documentation. Chapters in Part 2 are numbered 2A, 3A, etc., to correspond with the chapters in Part 1 which they amplify and support. Chapters 1 and 6 in Part 1, entitled, respectively, What Is the Outlook, and Recapitulation, may be read by themselves for a rapid statement of the problems and conclusions. And of course the reader may prefer to take chapter 2, then 2A, 3 and 3A if he wants his complete proofs as he goes along. It should be added that Part 1 includes sufficient statistics to provide at least one proof for each argument presented.

The author sees no solution, and is frankly pessimistic about the intellectual outlook for ambitious and capable young people. Changes which might soften but not solve the problem would be a lowering of restrictions on admission to professional training, which Mr. Harris believes especially severe in medicine, and a change in social and economic evolution which would lead to the expenditure of a larger percentage of the national income on tertiary (professional, managerial, and service) occupations. An increase in enrollment in medical schools, for instance, would lead, the author believes, to an increase in available medical service, to lower fees because of competition, and hence to more general use and a higher total expenditure.

The mass of statistical material assembled in this volume is convincing, but reference to the many items is beyond the limits of a review. For instance, the impact on the problem of professional opportunity of the increase of women in these fields is treated in detail as are the problems of unequal average individual incomes in various sections of the country and the maldistribution, geographically, of professional workers.

"The Market for College Graduates" is well worth reading and engineers and engineering educators would do well to ponder its warnings.

Theory of Wing Sections

THEORY OF WING SECTIONS. Including a Summary of Airfoil Data. By Ira H. Abbott and Albert E. von Doenhoff. McGraw-Hill Book Company, Inc., New York, N. Y.; Toronto, Can.; London, England, 1949. Cloth, 6 × 9 in., viii and 693 pp.; illus., graphs, diagrams, figs., references, $15.

REVIEWED BY F. K. TEICHMANN[1]

INTENDED to serve primarily as a reference for engineers, but also a supplementary text and reference for students as well, this volume presents concisely the most important and useful research aerodynamic data of wing sections at subcritical speeds.

Approximately 300 pages are devoted to presentation of theoretical and experimental considerations involved. The authors have attempted to keep the mathematics to a minimum, but a knowledge of differential and integral calculus as well as elementary mechanics is presupposed.

Among the subjects treated are the significance of wing section characteristics; simple two-dimensional flows; theory of thin and finite thick wings; effects of viscosity; effects of compressibility at subsonic speeds; families of wing sections and their experimental characteristics; high-lift devices.

The text is amply illustrated with diagrams, tables, and case problems so that the theoretical discussions take on a greater significance, especially to the practicing engineer who may not be so familiar with the field of aerodynamics.

Very useful to the engineer, also, is the list of some 160 references where more specific and detailed information may be found, if desired.

In the four appendixes are collected (1) the basic thickness forms of 36 NACA airfoils (2) mean lines (3) airfoil ordinates (4) aerodynamic characteristics of 118 NACA wing sections.

The practicing engineer will find this volume valuable not only for finding the aerodynamic theories most useful in working with wing sections and methods for using section data to predict wing characteristics, but also in having for immediate reference much detailed geometric and aerodynamic data relating to commonly used airfoils of today.

[1] Professor and chairman, department of aeronautical engineering, College of Engineering, New York University, New York, N. Y. Mem. ASME.

Books Received in Library

ALLOY STEELS, CAST IRON AND NON-FERROUS METALS. By F. Johnson. Chemical Publishing Co., Brooklyn, N. Y., 1949. Linen, 5½ × 8¾ in., 227 pp., illus., diagrams, charts, tables, $5. Essentially a reference work, this book covers the general aspects of steelmaking processes and their relation to the properties of alloy steels. The physical and chemical properties and the applications of individual steels and cast irons are discussed and illustrated. The heat-treatment of steels, cast irons, and nonferrous metals and alloys are considered in some detail. There is a special chapter on age-hardening.

HEAT POWER FUNDAMENTALS. By C. M. Leonard and V. L. Maleev. Pitman Publishing Corporation, New York, N. Y.; Toronto, Canada; London, England, 1949. Cloth, 6 × 9¼ in., 596 pp., illus., diagrams, charts, tables, $5.75. This book is written for use in a first course in heat-power engineering. The first part deals with steam-power plant and contains basic theory of thermodynamics. The second part is devoted to a study of gas-power plants, both of the reciprocating engine and turbine types. The last part describes mechanical refrigeration. Tables of properties of steam and air are appended.

HEAT PUMP, ITS PRACTICAL APPLICATION. By J. B. Pinkerton. Princes Press Ltd., Westminster, London, England, 1949. Cloth, 6¼ × 9½ in., 257 pp., illus., diagrams, charts, tables, 25s. Based on a series of articles in *Air Treatment Engineer*, this book is written for the engineer who is concerned with the design, installation, or maintenance of heat-pump installations. Following the section on theory, practical applications are considered. The third and last section deals with the development of atomic energy as a fuel. A bibliography is included.

INTRODUCTION TO THE GAS TURBINE. By D. G. Shepherd. D. Van Nostrand Co., Inc., New York, N. Y., 1949. Cloth, 5½ × 8¾ in., 387 pp., illus., diagrams, charts, tables, $5. Filling the gap between nontechnical descriptive matter and very specialized reports, this book provides an introduction to gas-turbine theory and design. Following initial chapters on the basic physical and engineering concepts, the various components are described, and an outline of some design methods given. The remaining chapters discuss auxiliary equipment and control methods and provide illustrations of the practical use which is made of the constant-pressure gas turbine. Specialized calculations are dealt with in appendixes. Chapter bibliographies are included.

JET-PROPELLED AIRCRAFT POWER PLANTS. By J. P. Eames. Pacific Aero Tech, San Francisco, Calif., 1949. Fabrikoid, 5½ × 8 in., 121 pp., illus., diagrams, charts, tables, $3. Following a brief review of fundamentals, compressorless jet, turbojet, propjet, and pocket-jet power plants are treated in a concise manner. Maintenance problems are discussed and construction materials are described. A glossary of terms is included.

LIGHT METALS INDUSTRY. By W. Lewis. Temple Press, Ltd., London, England, 1949. Linen, 5½ × 8½ in., 397 pp., illus., diagrams, charts, maps, tables, 21s. Four fifths of this book is devoted to aluminium. The several chapters cover ores and their treatment, the principal alloys, the various fabricating processes, secondary aluminium, and the conditions, markets, and statistics of the aluminium industry. The remaining one fifth covers briefly the same material for magnesium and beryllium.

MACHINERY'S HANDBOOK FOR Machine Shop and Drafting-Room. By E. Oberg and F. D. Jones. Fourteenth edition. Industrial Press, New York, N. Y.; Machinery Publishing Co., Ltd., Brighton, England, 1949. Fabrikoid, 4¾ × 7¼ in., 1911 pp., diagrams, charts, tables, $7. This standard annual reference book provides essential data and information on machine design and shop practice for the mechanical engineer, draftsman, toolmaker and machinist. New material includes recent or revised engineering standards as well as additional developments reflecting current designing and manufacturing practice. As is customary, the extensive technical and mechanical data are presented in tabular form for convenience of use. Material concerning metallurgical, hydraulic, and other allied fields is given, and the whole compilation is covered by a thirty-page index.

METALS REFERENCE BOOK. By C. J. Smithells. Interscience Publishers, New York, N. Y. Butterworths Scientific Publications, London, England, 1949. Linen, 6¼ × 9¾ in., 735 pp., diagrams, charts, tables, $13.50. Of use to scientists and engineers, this comprehensive reference book is a summary of a wide range of physical, mechanical, and electrical data relating to metallurgy and metal physics. For the most part, data are presented in the form of tables and diagrams; but short monographs are used where the information could not otherwise be adequately presented. The values given are those selected from a critical review of the published literature. A limited bibliography is included at the end of each section.

METHODS OF JOINING PIPE. By J. E. York. Industrial Press, New York, N. Y., 1949. Fabrikoid, 5½ × 8¾ in., 236 pp., diagrams, tables, $3; to foreign countries, $3.40. Illustrates and describes all types of pipe joints, including expansion joints, for different classes of metallic and nonmetallic piping, with discussion of their advantages and disadvantages. The proper selection of pipe joints, based on consideration of influencing factors, is also covered.

NON-LINEAR PROBLEMS IN MECHANICS OF CONTINUA. (Proceedings of Symposia in Applied Mathematics, volume 1.) Published by the American Mathematical Society, New York, N. Y., 1949. Cloth, 10¼ × 7 in., 219 pp., diagrams, charts, tables, $5.25. This volume contains papers presented at the First Symposium on Applied Mathematics, 1947, of the American Mathematical Society. The papers have been subdivided into two groups: one concerned with the field of hydro- and aerodynamics; the other including results in electricity and plasticity. A few of the papers presented at the Symposium were published elsewhere, and of these comprehensive abstracts are given.

PRINCIPLES OF AERODYNAMICS. By J. H. Dwinnell. McGraw-Hill Book Company, Inc., New York, N. Y.; Toronto, Canada; London, England, 1949. Cloth, 6 × 9¼ in., 391 pp., illus., diagrams, charts, tables, $5.50. This undergraduate textbook serves as an introduction to some of the more important theoretical and practical aspects of aerodynamics. Following the development of a principle, experimental data are presented for verification purposes. In all cases, numerical examples are used to clarify explanations. Not only answers to problems but also the most important steps required in their solution are included.

PRINCIPLES OF AIRCRAFT PROPULSION MACHINERY. By I. Katz. Pitman Publishing Corporation, New York, N. Y.; Toronto, Canada; London, England, 1949. Cloth, 6 × 9¼ in., 477 pp., illus., diagrams, charts, tables, $6.50. Intended for all those who are interested in aviation, this book considers the fundamental aspects and nature of aircraft propulsion machinery. It evaluates the real worth of existing equipment in the light of historical data and current developments. References and problems are included to amplify and extend the text. A notable feature is the effective balance between analytical and descriptive matter and the integration of theory with practice.

PUMP QUESTIONS AND ANSWERS. By R. Carter, I. J. Karassik, and E. F. Wright. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1949. Cloth, 6 × 9¼ in., 346 pp., illus., diagrams, charts, tables, $5. This book covers the construction, application, operation, installation, and maintenance of pumps. In five major sections, centrifugal, vertical turbine, regenerative, rotary, and reciprocating pumps are dealt with separately.

REFRACTORIES. By F. H. Norton. Third edition. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1949. Cloth, 6½ × 9¼ in., 782 pp., illus., diagrams, charts, tables, $8.50. Dealing mainly with the fundamental processes involved in the manufacture and use of refractories, this third edition provides new material on nonplastic casting, hydrostatic molding, hot pressing, laboratory furnaces, properties of pure refractory materials, and refractories for nuclear-power generation and jet propulsion. The sections on molding, plasticity, raw materials, firing, refractories for steel manufacture, and refractories for steam-power generation are considerably rewritten. Brickwork construction and special refractories are among the other topics dealt with.

REFRACTORIES, published by the General Refractories Company, Philadelphia, Pa., 1949. Cloth, 8½ × 11¼ in., 272 pp., illus., diagrams, tables, $5. This book is intended for those who design, use, purchase, construct and supervise the operation of equipment requiring refractory materials. It relates the story of refractories from earliest times to the present day, describes the forms of refractories and their uses, and gives details of how refractories are made and the types available for the requirements of various industries. Specified uses, descriptive information, and technical data for the publisher's products form a basic part of the book.

SPECIFICATIONS AND TESTS FOR ELECTRODEPOSITED METALLIC COATINGS, sponsored by American Society for Testing Materials and American Electroplaters' Society, October, 1949. American Society for Testing Materials, Philadelphia, Pa. Paper, 6 × 9 in., 62 pp., diagrams, charts, tables, $1.25. In this compilation are specifications for various types of electrodeposited coatings on steel, copper and copper-based alloys, and zinc and zinc-based alloys. Two test methods—one for local thickness of electrodeposited coatings, the other for salt-spray (fog) testing—are included. There are also three items presenting recommended practices.

STANDARDS OF TUBULAR EXCHANGER MANUFACTURERS ASSOCIATION. Second edition. Tubular Exchanger Manufacturers Association, New York, N. Y., 1949. Paper 8½ × 11 in., 93 pp., diagrams, charts, tables, $3; stiff paper (fabrikoid), $4. This publication contains recommended standards, consistent with safety and service requirements of the Association, for the mechanical and thermal design and construction of cylindrical-shell and bare-tube heat exchangers.

SURFACE TENSION AND THE SPREADING OF LIQUIDS. By R. S. Burdon. Second edition. Cambridge University Press, American Branch, New York, N. Y., 1949. Cloth, 5½ × 8¼ in., 92 pp., illus., diagrams, charts, tables, $2.50. Following a general discussion the author deals with particular aspects such as the spreading of dissimilar liquids on each other, liquids on solids, etc. The book does not contain detailed analyses or descriptions of experimental methods. Emphasis is placed on things not in the textbooks and on matters where uncertainty exists or progress is being made. Technical applications briefly treated include lubrication and the flotation of minerals.

SYMPOSIUM ON COMBUSTION AND FLAME AND EXPLOSION PHENOMENA, Third, Madison, Wisconsin, September 7–11, 1948; published under the auspices of the Standing Committee on Combustion Symposia, Bernard Lewis, Chairman, Hoyt C. Hottel, Secretary, and A. J. Nerad. Williams & Wilkins Company, Baltimore, Md., 1949. Cloth, 7 × 10¼ in., 748 pp., illus., diagrams, charts, tables, $13.50. Containing 100 papers written for the symposium, this book covers the following topics: flame stabilizing and quenching; flame propagation in explosive gas mixtures; flames of fuel jets; ignition of gas mixtures; kinetics and mechanism of combustion reactions; flame spectroscopy and radiation; burning and detonation of explosives; thermodynamics of flame gases and thermochemistry; experimental techniques; combustion in engines and rockets; and gas burners and furnaces.

TECHNOLOGY OF LIGHT METALS. By A. von Zeerleder, translated from the first Swiss edition by A. J. Field. Elsevier Publishing Company, New York, N. Y.; Amsterdam, Holland; London, England; Brussels, Belgium, 1949. Cloth, 6¼ × 10 in., 366 pp., illus., diagrams, charts, tables, $6. For those interested in the manufacture and use of aluminum and magnesium and their alloys, this book covers these metals from the ore to the semi-manufactured goods, including all the latest developments of recent years. Topics dealt with include properties and methods of testing, melting furnaces, fabricating processes, joining methods (welding, riveting, etc.), alloy types, and surface treatment. A bibliography of the more important references in the literature is included.

THEORY OF WING SECTIONS, including a Summary of Airfoil Data. By I. H. Abbott, A. E. Abbott and A. E. von Doenhoff. McGraw-Hill Book Company, Inc., New York, N. Y.; Toronto, Canada; London, England, 1949. Linen, 6 × 9¼ in., 693 pp., illus., diagrams, charts, tables, $15. Based on research by the National Advisory Committee for Aeronautics, this text presents the most useful aerodynamic theories of wing sections together with a comprehensive summary of experimental results. The theoretical treatment progresses from elementary considerations to methods used for the design of low-drag airfoils. Methods are discussed for using section data to predict wing characteristics. Numerous charts and tables and a bibliography are included.

DIE THERMODYNAMIK DES WARME- UND STOFFAUSTAUSCHES IN DER VERFAHRENSTECHNIK. By W. Matz. Verlag Dr. Dietrich Steinkopff, Frankfurt (Main), Germany, 1949. Paper, 6¼ × 9 in., 355 pp., diagrams, charts, tables, 26 DM (28 DM, linen). This book applies the scientific principles of thermodynamics to the understanding of heat and material exchange as they occur in the process industries. Following a review of basic principles, heat and material exchange between two phases is discussed and then applied to the vapor and liquid states. The special cases of distillation, adsorption, absorption, and extraction are considered. A vector-analysis treatment of thermodynamic cycles is appended.

TITANIUM IN STEEL. By G. F. Comstock, S. F. Urban, and M. Cohen. Pitman Publishing Corporation, New York, N. Y., Toronto, Canada; London, England, 1949. Cloth, 6 × 9¼ in., 320 pp., diagrams, charts, $7.50. This volume is a correlation and critical summary of available data on the use of titanium as a deoxidizer, as a carbon and nitrogen-stabilizing element, and as an alloying metal in steel. Brief reference is made to the older literature, but the more recent and more accurate data are so detailed that it should be unnecessary to consult the original works. Almost 300 references are included in the bibliography.

DAS TRIEBWERK SCHNELLAUFENDER VERBRENNUNGSKRAFTMASCHINEN. (Die Verbrennungskraftmaschine, Band 10.) By H. Kremser. Second edition revised. Springer-Verlag, Vienna, Austria, 1949. Paper, 7¾ × 10½ in., 166 pp., illus., diagrams, charts, tables, $7.20. Part of a large, comprehensive set in the general field of the internal-combustion engine, this book contains a concise survey of the material, physical, and technical properties of high-speed mechanism in internal-combustion engines. Pistons, crankshafts, crankshaft and shaft bearings, and connecting rods are discussed in detail. A short bibliography is included.

WELD DESIGN. By H. D. Churchill and J. B. Austin. Prentice-Hall, New York, N. Y., 1949. Cloth, 5¾ × 8¾ in., 216 pp., illus., diagrams, tables, $6.65. This concise volume considers both the practical and theoretical aspects of welded machine-base design. Construction materials and methods of processing plates and structural shapes are treated in detail. Welding technique is not considered. The appendixes contain stress design data and a bibliography of magazine articles and books.

ASME BOILER CODE

Interpretations of API-ASME Code for Unfired Pressure Vessels

THE API-ASME Committee on Unfired Pressure Vessels, on January 9, 1950, released the following announcement to replace the Note on page 6 of the 1943 Edition of the API-ASME Code:

Pending the formulation and adoption of a section of the API-ASME Code to provide additional rules for the use of high-alloy steels, as well as for the use of the high strength[1] steels, the following approved ASME Cases are listed by number and descriptive title. In applying these Cases, the API-ASME rules for design and inspection, including radiographic examination except where the latter is required in the Case for the detection of cracks in air-hardening materials, may be followed. The rules governing fabrication shall be those given in the ASME Code except as modified below. For materials covered by ASME Cases only, and for which stress values are not shown in Table U-2 in the ASME Code, the factor of 1.25 may be applied to the stress values given in the case unless therein specifically prohibited.

In some of the ASME Cases the heat-treatments prescribed, subject to limiting thicknesses for specific materials and service temperatures, are only intended to obtain most favorable corrosion resistance. In cases where heat-treatment is prescribed for the purpose of increasing corrosion resistance, the heat-treatment is not mandatory under the API-ASME Code if no corrosion is expected. Heat-treatment is mandatory under the API-ASME Code, however, when prescribed in the ASME Cases for the purpose of stress relieving air-hardening materials that have been welded.

Vessels of high-alloy steels may be intended for liquids and vapors corrosive to most plain carbon steels listed in Table 1 of the API-ASME Code. The corrosion resistance and the allowance for loss due to corrosion are not specifically covered in the ASME Cases. It is recommended, therefore, that prospective users of high-alloy steel vessels assure themselves, by appropriate tests or by reference to available authentic data, that the alloy steel selected and its treatment before and after fabrication are suitable for the service intended.

When a case is reopened by the ASME Boiler Code Committee, the latest form of that Case shall govern its application under the API-ASME Code. When a Case is annulled because its permissive provisions are withdrawn, it is automatically canceled under the API-ASME Code.

CASE NO. 896—Fusion-welded pressure vessels of integrally clad material conforming to ASTM Specifications A-263, A-264 and A-265. In conformation of a ruling made by the API-ASME Committee in 1943, the full thickness of the composite plate may be used in the design calculations, notwithstanding the provisions to the contrary in W-308 (see Case No. 1078 for vessels with applied linings).

For temperatures up to and including 900 F, and for base materials listed in Table 1 of the API-ASME Code, the allowable stress shall be that given in Table 1 for the base material. For higher temperatures, or for base materials not listed in Table 1, the allowable stress shall be 1.25 times that given in Table U-2 of the ASME Code.

CASE NO. 897—Unfired pressure vessels of chrome-nickel steels as such, or alloyed with columbium, titanium, or molybdenum, conforming to ASTM specifications.

CASE NO. 898—Unfired pressure vessels subject to external pressure using stainless steels that are covered by Case No. 897.

CASE NO. 941—Welded unfired pressure vessels of high-tensile manganese molybdenum steel conforming to ASTM Specification A-204, modified.

CASE NO. 987—Use of forged flanges for high-temperature service especially adaptable to welded construction conforming to ASTM Specification A-182, modified.

CASE NO. 989—Welded unfired pressure vessels of chromium steels conforming to ASTM Specification A-240, Grade A (Type 410 modified), Grade B, and Grade D (Type 430 modified) for sheets and plates; to ASTM Specification A-182, Grade F6 (Type 410) and Grade D (Type 430 modified), for forgings; to ASTM Specification A-158, Grade P6 (Type 410), for pipe; to ASTM Specification A-221, Grade A (Type 410), for castings.

CASE NO. 1030—Use of centrifugal castings of 29 per cent chromium and 9 per cent nickel alloy steel for the main shell and nozzles of welded unfired pressure vessels, when the material complies with ASTM Specification A-222, Class C modified.

CASE NO. 1078—Fusion-welded pressure vessels with applied linings (See Case No. 896 for integrally clad vessels).

CASE NO. 1080—Procedure qualification for steel under ASTM Specification A-299.

The API-ASME Committee on Unfired Pressure Vessels has also approved ASA Supplement No. 1 (B16e6-1949) to B16e-1939 for "Service Pressure Ratings for Steel Pipe Flanges and Flanged Fittings," with modification that all ratings at service temperatures up to and including 1000 F shall apply to steam as well as to oil and gas.

[1] ASTM A300, A301, and A302 are not included in this group.

THE ENGINEERING PROFESSION

News and Notes

As Compiled and Edited by A. F. Bochenek

Accident Control and the ASME

In one of its recent reports the National Safety Council published statistics on industrial accidents which should disturb the engineering profession and particularly mechanical engineers who are most concerned with industrial processes. The report shows that annual disabling injuries in American factories have reached 2,000,000, including 90,000 permanent impairments, and 17,000 deaths. This accident rate means an annual time loss of 280,000,000 man days (not including deaths and permanent injuries) which is equal to the working time of 1,000,000 men and a money loss of more than 2.5 million dollars annually.

The American Society of Mechanical Engineers through its Safety Committee is particularly sensitive to industrial accident statistics not only because they reflect on the engineering profession, but because they serve as an index of industrial efficiency. To combat industrial accidents, the ASME Safety Committee has recently inaugurated two projects. The first aims to increase the number of members serving on its committees and contributing to its programs; and the second establishes a review board of experts whose job it is to review the accident-loss control problems submitted to it by ASME members and to suggest remedial programs.

To take advantage of this free service, members need only send the details of their accident-loss problems to the ASME Safety Committee at Society Headquarters in New York, N. Y. The Committee will keep its replies confidential and if the problem is of general interest, it will arrange to have the facts published in Mechanical Engineering without reference to actual persons or places. The Safety Committee feels that this will be an important service to society members and may help to reduce the current accident rate.

Safety an Engineering Problem

The ASME has a responsibility to industry and the engineering profession because accident prevention is primarily an engineering problem. Whenever an accident occurs there is either something wrong with the equipment or the manner in which the job was done, or, stated in another way, accidents are caused only by an unsafe mechanical condition or an unsafe act by a person. Since mechanical engineers deal in machines and industrial methods, they have a legitimate interest in accident prevention over and above their concern for needless human suffering.

ASME interest in industrial safety goes back to the early days of the Society. In 1911 the ASME tackled the high incidence of boiler explosions in the steam-power field by appointing a committee to prepare standard specifications for construction of boilers and pressure vessels and for operation of such equipment. As a result of the ASME Boiler Code Committee activities, boiler explosions today are hardly known in spite of the tremendous expansion of the steam-power industry since 1911 and the high pressures currently in use. The ASME Boiler Code has been adopted by 38 states, Hawaii, Puerto Rico, Panama Canal Zone, and by nine provinces of Canada. The revision and interpretation of the Boiler Code depends upon the services of 190 members.

Encouraged by its successes in promoting safety in boiler construction and operation, the Society began to study the accident record in the elevator field. In 1921 the first ASME Safety Code for Elevators covering construction, inspection, maintenance, and operation of elevators, dumbwaiters, escalators, and hoistways, was published. A year later the Code was widely adopted by state and municipal bodies. To provide broader sponsorship for the Code, the Society invited the American Standards Association to organize a sectional committee in which representatives of the American Institute of Architects and the National Bureau of Standards were represented. As the mechanical arts in the elevator industry developed, the elevator Code was revised to keep it in line with latest practices. The Code is currently being revised for the fourth time by a 42-member committee representing building, manufacturing, insurance, governmental, labor, and other interests.

These successes in promoting industrial safety prompted the Society to initiate an American Standard Safety Code for Cranes, Derricks, and Hoists which was published in 1943. To complete the series of codes dealing with safety in vertical transportation, the Society, in 1949, published the American Standard Safety Code on Manlifts.

But the series of elevator and boiler codes represents only a portion of the ASME safety program. Since 1915, when the Society, "recognizing safety as an essential element of good engineering and management," appointed a Standing Committee on Safety, more than 30 safety codes have been formulated on such subjects as abrasive wheels, aeronautics, conveyers, forgings, industrial lighting, sanitation, ventilation, refrigeration, power presses, and ladders. In these safety projects ASME members have worked closely with the American Standards Association and with a host of other industrial and trade agencies interested in safe standard practices.

Because safety required the constant vigil on the part of engineers, the Society, through its Safety Committee, is constantly keeping alive this subject of accident prevention at Society national meetings and divisional conferences. In an attempt to provide a measure for effectiveness of accident-control programs, the Society formulated a self-appraisal form for industrial plants. This form, which can easily be filled out by a plant manager, takes into account and evaluates the various factors of accident control such as planning, construction, safeguarding, housekeeping, storage supervision, and education of workers, and helps a manager to judge his operations against a suggested minimum practice.

Realizing that safety is essentially a habit of thought, the Committee has sought to integrate accident-control ideas into the courses of engineering schools. The Committee's plan is to study course outlines with the idea of substituting illustrations of an accident-control nature which would make the student more aware of the possibility of eliminating accidents by proper control. Progress in promulgating accident prevention, however, cannot reach its maximum until the student engineer realizes that safety is part of his engineering thinking. Under way at the present time is a program for the control of university accidents. When completed, the document will serve to guide student groups in the initiation of safety programs for American universities.

Heavy Work Load

Today the potential work load of the ASME Safety Committee is greater than ever. If the Society is to face the disturbing implications of the high industrial accident rate reported by the National Safety Council, it must recruit from among its members the technical man power to prosecute its safety programs. The ASME Safety Committee needs men for the following purposes:

1 To increase the number of qualified men for safety-code assignments.

2 To contribute ideas and to give support to the program for integrating safety knowledge into engineering curriculums.

3 To keep the Society informed of accident-control subjects for discussions at national meetings and divisional conferences.

4 To support safety activities by attending safety meetings and contributing discussion.

5 To propagate the use of safety codes.

6 To present papers on the subject of industrial accident control before the Society.

7 To encourage engineers to use the services of the ASME Safety Committee Review Board on accident-control problems.

Members who have an interest in safety work are urged to write to John V. Grimaldi, chairman, ASME Safety Committee, 29 West 39th Street, New York 18, N. Y.

AIEE Members Favor Policy of Restricting Activities to Technical Matters

Nontechnical Objectives to Be Sought in Unification

THREE out of every four members of the American Institute of Electrical Engineers who voted in the recent opinion poll, expressed themselves in favor of the current AIEE policy of adhering to the technical field and against the policy of expanding into the nontechnical field with substantial increases in dues. On the basis of returns and written comment, the board of directors tentatively agreed on the following policy objectives: (1) To work continually for the unification of the profession; (2) to recognize the fact that the Institute finds its chief reason for existence in the technical field; and (3) to handle questions on nontechnical affairs as necessary and as they arise on an emergency basis until through unification they can be handled on a general professional basis. To confirm these objectives, AIEE members have been asked to fill out another opinion questionnaire which appeared in the March issue of *Electrical Engineering*.

AIEE leadership had generally assumed that younger engineers would favor expansion into economic and social fields. Returns, however, did not bear this out. In sections where students were asked to vote, their returns followed the pattern set by older members.

Commenting on the three policy objectives for which approval of AIEE members is being sought, Mr. Fairman said, "Under item 1 the Directors will continue and, if possible, strengthen their efforts to speed up Engineers Joint Council exploration and consummation of unification. For the many members who are much concerned about the problem of what to do in the interim, it suggests and endorses individual participation in the National Society of Professional Engineers, section participation in local councils, and individual, local, and national preaching of the gospel of unification.

"Under item 2 the present concentration on technical activities will continue. Included in technical activities are matters of membership, prize awards, education, publication, and co-operation with other societies on technical questions. These in turn require the maintenance of an active program of public relations, nationally and in the section areas.

"Registration will be included as a sort of capstone of the educational process. While a good deal of educational activity might ultimately be handled best by the suggested over-all organization, nevertheless, Engineers' Council for Professional Development work must continue in its present fashion in the interim period.

"Under item 3 it should be recognized that the restricted emergency actions of the Board of Directors in the nontechnical field will be much less effective than some would desire. This in itself, however, will tend to accelerate the final completion of some satisfactory form of over-all organization."

Meetings of Other Societies

April 10–12
American Society of Lubrication Engineers, annual meeting, Hotel Statler, Detroit, Mich.

April 17–19
Society of Automotive Engineers, Inc., aeronautic meeting and aircraft engineering display, Hotel Statler, New York, N. Y.

April 20–21
The Society for the Advancement of Management, time study and methods conference, Hotel Statler, New York, N. Y.

April 24–26
American Mining Congress, coal-mining convention, Netherland Plaza Hotel, Cincinnati, Ohio

April 24–26
National Academy of Sciences, annual meeting, Hotel Washington, Washington, D. C.

April 26–29
American Society of Civil Engineers, spring meeting, Ambassador Hotel, Los Angeles, Calif.

(*For ASME Calendar of Coming Events see page 358*)

Israel Looks to Engineers

THE FUTURE of the new nation of Israel lies with its engineers and scientists rather than with its farmers, according to I. I. Rabi, professor of physics at Columbia University, New York, N. Y., and the 1944 Nobel Prize winner for physics.

Speaking recently before a luncheon meeting of the American Technion Society honoring authors contributing to its 1949 Yearbook, Dr. Rabi said that American engineers could help Israel survive by helping her to model her economy after Switzerland rather than after a country rich in natural resources.

The American Technion Society is an organization of engineers and scientists dedicated to the advancement of the Hebrew Institute of Technology, Haifa, Israel. ATS fosters engineering education in Palestine by contributing funds and engineering literature. Through its membership, it makes American know-how available for the solutions of engineering problems of the new nation.

The Institute is the only engineering school in Israel. Total enrollment exceeds 1200 including fifty American veterans studying under the G. I. Bill of Rights. ATS has the support of many members of the ASME.

Engineering Literature

Thermostatic Bimetals

A BIBLIOGRAPHY on Thermostatic Bimetals, Low-Expansion Alloys, and Their Applications, containing 320 references complete with annotations, was published recently by The American Society of Mechanical Engineers. The 52-page booklet is the work of the ASME Instruments and Regulators Division. The bibliography covers the historical development from the early 19th century, the use of various materials; the studies of the anomalous expansion properties of the nickel steels and the attempts to explain them; the complete work of Guillaume, which led to his Nobel Prize; surveys of theoretical and practical design; considerations and descriptions of applications in thermostats, in chrometers and watches, for heated spaces, furnaces and motors. Price is $1.

Screw Threads

AS PART of the international project to unify engineering practices dealing with screw threads the ASME has published recently the American Standard "Nomenclature, Definitions, and Letter Symbols for Screw Threads." The 15-page document consists of a glossary of terms, two tables of screw-thread dimensional symbols, five illustrations showing the application of dimensional symbols, and one table of identification symbols. Sponsored by the Society of Automotive Engineers and the ASME, the standard is based on careful study and much discussion on both sides of the Atlantic. Cost per copy is 50 cents.

Boiler Code

INTERPRETATIONS of the ASME Boiler Construction Code, corrected to Jan. 1, 1950, have been published in booklet form for convenience of users. The interpretations are indexed by case number and by subject, and are essential to understanding the code proper. Price per copy is $2.50.

Also available are the 1949 addenda to the Material Specifications of the ASME Boiler Construction Code. Price is $1.

New editions of Sections IV and V of the ASME Boiler Construction Code covering rules for construction of low-pressure heating boilers and miniature boilers, respectively, have been issued by The American Society of Mechanical Engineers. The new editions incorporate all addenda to the Code issued since 1946. Price of Section IV, Low-Pressure Heating Boilers, is $1, and that of Section V, Miniature Boilers, is 75 cents.

Code Corrections

A NUMBER of typographical, editorial, and stylistic corrections have been made for the second printing of the 1950 edition of Section VIII—Unfired Pressure Vessels.

A list of these corrections is available on request from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

ASME Elects Seven Fellows

THE American Society of Mechanical Engineers has honored seven of its members by electing them to the grade of Fellow of the Society.

To be qualified as a nominee to the grade of Fellow one must be an engineer who has acknowledged engineering attainment, 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and has been a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of the Society to the Council to be approved by Council.

The men who, by virtue of their contribution to their profession and to the Society, were so honored are:

Samuel Reid Beitler

Samuel R. Beitler, professor of mechanical engineering, in charge of work on hydraulics and fluid mechanics, Ohio State University, was born in Carey, Ohio, March 19, 1899. He received the degree of BME, 1920, and ME, 1932, from Ohio State University. Professor Beitler is responsible for the conduct of the principal research in this country on fluid metering and the correlation of the results into useful form. He has been a member of the ASME Special Research Committee on Fluid Meters since 1931. With E. J. Lindahl, Mem. ASME, he was co-author of "Hydraulic Machinery." He contributed many excellent books and papers on the subject and holds patents in the field.

Nathan Bert Higgins

Nathan Bert Higgins, president, Safe Harbor Water Power Corporation, and advisory engineer, Pennsylvania Water and Power Company, supervises the engineering of new projects and other work on the combined system of both companies. He was born in Morris Run, Tioga County, Pa., Feb. 15, 1885. In 1909 he received a BSCE degree from Pennsylvania State College and in 1922 a certificate in electrical engineering from The Johns Hopkins University. He was responsible for the design and construction of the Holtwood hydroelectric development of the Pennsylvania Water and Power Company between 1914-1924, also the 25,000-kw steam-electric station at the same location, and the design and construction of the Safe Harbor hydroelectric project of the Safe Harbor Water Power Corporation. He is the author of several articles on various phases of the Holtwood and Safe Harbor projects. Mr. Higgins has contributed to the management of the local sections of ASME; for four years he was a member of the Executive Committee of the Baltimore Section and previously he had served on its Nominating Committee.

Ernest Leroy Hopping

Ernest Leroy Hopping, consulting engineer, was born in Philadelphia, Pa., Aug. 30, 1884, and attended The Franklin Institute and Temple University. Since 1917 Mr. Hopping was in charge of all mechanical-engineering activities for the Philadelphia Electric Company. During this period Philadelphia Electric Company pioneered in many new developments, notable among which are water-cooled furnace settings and air preheaters. The imprint of Mr. Hopping's thoroughness, breadth of vision, and engineering genius are reflected in each of these many construction operations. He served on the ASME Power Division Executive Committee, Philadelphia Section Executive Committee, Committee on Medals, and Board on Honors. For three years he was on the technical advisory committee of the War Production Board. His contributions to the literature of power generation cover many important subjects in this broad field of central-station engineering.

Burgess Hill Jennings

Burgess H. Jennings, engineering consultant to the Argonne National Laboratory, was born in Baltimore, Md., Sept. 12, 1903. Mr. Jennings has been an outstanding educator in the field of mechanical engineering and he has contributed greatly to the development of many young men who themselves have become outstanding teachers in the field. Many of his other students have been exceptionally successful and hold excellent jobs in the engineering world at the present time. He has been the author of many papers and books. Three textbooks which he co-authored have been used extensively in engineering schools. He holds patents on absorption-refrigeration devices and a glycol vaporizer.

Albert Ludovic Maillard

Albert Ludovic Maillard, president, Electric League of Indianapolis, Inc., was born in Port of Spain, Trinidad, Feb. 21, 1888. He attended St. Mary's and Queen's Royal College for four years and in 1914 received the BSME degree from Catholic University of America.

In 1923 he designed a 13,200-volt waterworks pumping station in Kansas City, Kan., utilizing 20,000-hp motors to drive centrifugal pumps. It was the first of its voltage and size in the country. While with the Kansas City Power and Light Company he had installed a 550-kva rotary converter to operate in parallel with the *Kansas City Star's* power plant comprising three uniflow engines. He had the responsibility of directing the operations of this plant for one year to meet the guarantees he made to the *Star*. At Lake City Ordnance Plant near Kansas City he was in charge of laying out and supervising the installation of the grounding system in the dangerous explosives plant. The results were drawn up and used as guides in at least six other plants. He has served as chairman of the Kansas City Branch of the Society.

From 1934-1938 he was on the special National Committee of Policies and Budgets of the ASME.

Carl Adolph Norman

Carl A. Norman, professor of machine design, Robinson Laboratory, Ohio State University, was born in Borga, Finland, Jan. 12, 1879. In 1900 he received the ME degree from The Royal Technical College, Stockholm, Sweden. Professor Norman has been a man with much vision. In evidence is his early conception of the ramjet in 1910; his advocating of the design of gas-turbine power plants in 1915, with his conviction that it would be a practical prime mover; his early proposals of using the Diesel engine as an automotive power plant; serving as the chairman of the SAE's first session on Diesel engines; and other recommendations of a pioneering nature.

His contributions to the field of mechanical power transmission has been notable with his extensive work on belt drives, being the originator of a thorough and fundamental belt-drive theory. He has been an excellent teacher, developing new methods of teaching machine design, giving not only training, but, also, inspiration to several thousand students. Since early years in teaching he has been giving due emphasis to the human aspects of engineering. He is the author of several books and holds patents on a life-testing machine for V-belts, on gas-turbine and steam-turbine cycles, and many patents in connection with hydraulic and electric automotive transmission.

Edward Eugene Williams

Edward E. Williams, general superintendent of steam plants of the Duke Power Company, Charlotte, N. C., and since October, 1946, member of the board of directors, was born in Birmingham, Ala., March 24, 1892. For the past 25 years Mr. Williams' major field has been operation, maintenance, and management of power stations. While Mr. Williams has been general superintendent of steam stations the capacity of the Duke steam plants has grown from 66,000 kw to a capacity of 650,000 kw (installed). There are at present under construction two steam stations. Mr. Williams has served the Society as chairman of the Charlotte Section, now known as the Piedmont-Carolina Section, 1928. He has been active on various ASME committees, in North Carolina sections, and student branches throughout the South. He was elected manager of ASME on June 18, 1945. In 1945-1946 he was Vice-President of ASME for Region IV and was re-elected for two successive terms.

He is the author of several articles describing the Riverbend Steam and Cliffside Steam Stations of the Duke Power Company.

Please Order Carefully

TO insure speedy attention, orders for ASME reprints, codes, standards, and special publications should specify clearly what items are wanted. Members should do this by identifying each item by its key number, if it has one, its full title, author, and date of issue. The more information you give, the more certain you can be that your order will be properly filled.

The ASME Order Department receives daily many ambiguous and often meaningless orders. Please be careful how you write your order.

ASME NEWS

Two Major ASME Meetings Scheduled for April

WASHINGTON, D. C., and Pittsburgh, Pa., will be the focal points of interest for members of The American Society of Mechanical Engineers this month. In Washington the ASME will hold its Spring Meeting, April 12–14, 1950, and in Pittsburgh on April 24–27, 1950, the ASME Process Industries Division will team up with the ASME Pittsburgh Section and other engineering groups for a program whose length and coverage approaches that of a regular Spring Meeting.

For those who have not yet taken time to look over the Spring Meeting program, reference is made to pages 267–269 of the March issue, where the tentative program appears in detail. The program is notable in several respects. The 1950 Thurston Lecture will be delivered by Theodor von Kármán, director of the Guggenheim Aeronautical Laboratory, California Institute of Technology, Pasadena, Calif. His subject will be "Specific Power Required for Propulsion of Vehicles (What Price Speed?)." Senator Ralph E. Flanders, past-president and honorary member ASME, will address the meeting on "A Mechanic in the Senate." For junior members a conference will be held at which the topic "How Is Your P.D. (Professional Development)?" will be discussed. William F. Ryan, vice-president, Stone and Webster Engineering Corporation, Boston, Mass., will be the main speaker.

A feature of the women's program will be a tea at Blair House with Mrs. Harry S. Truman as hostess.

For those who want to see some of the finest laboratories in the world, a number of inspection trips have been planned to the Naval Ordnance Laboratory, the David Taylor Model Basin, the Timber Engineering Company Laboratory the National Bureau of Standards, the Naval Engineering Experimental Station, and others.

Pittsburgh Meeting

At the 1950 Process Industries Conference and the Pittsburgh Section Mechanical Engineering Conference, the emphasis will be on blast furnaces, dust collection and control, design of chemical-process equipment, waste acid treatment, synthetic fuels, management, materials handling, driers, spray drying, and application of oxygen plants to process industries. The program is a rich one and is well worth a careful review. The program appears on pages 269–270 of the March issue.

High lights of the meeting will be two inspection trips, one to the Babcock & Wilcox Company plant at Beaver Falls, where the continuous casting of steel billets and the manufacturing of tubes will be seen. The group will be entertained by the Babcock & Wilcox Company at a luncheon in the General Broadhead Hotel prior to the trip through the plant. The second trip will be to the Robena Mine of the H. C. Frick Coke Company, near Uniontown, Pa. This mine is one of the world's largest and is an excellent one in which to observe modern mining techniques.

The Pittsburgh Section has invited student members of the Carnegie Institute of Technology, Virginia University, and the University of Pittsburgh to participate in the program. At each technical session, one student paper relating in a general way to the topic under discussion will be presented. The Section has been successful in integrating student branch activities into its affairs.

In addition to the inspection trips and an excellent technical program, a social program has been arranged for members and their wives.

GENERAL VEW OF THE ROBENA MINE SURFACE PLANT OF THE H. C. FRICK COKE COMPANY, ROBENA, PA., ONE OF THE PLANTS TO BE VISITED BY MEMBERS ATTENDING THE 1950 ASME PROCESS INDUSTRIES CONFERENCE, PITTSBURGH, PA.

32 Sessions Planned for 1950 ASME Semi-Annual Meeting

THE 1950 Semi-Annual Meeting of The American Society of Mechanical Engineers will be held in the Statler Hotel, St. Louis, Mo., June 19–23, 1950. The program currently taking shape under the guidance of the Meetings Committee and the ASME St. Louis Section will be composed of 32 technical sessions, a number of luncheons, a dinner, a ladies' program, and a series of inspection trips to some of the country's important industrial plants situated in the St. Louis area.

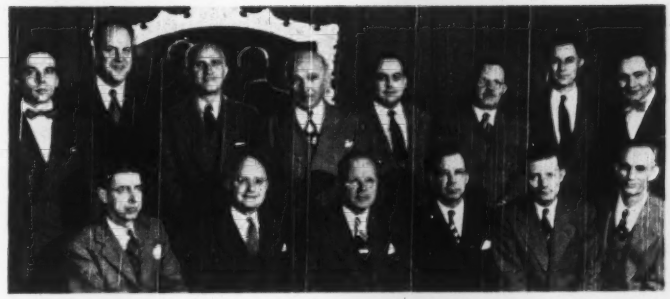
The following Professional Divisions and Committees are sponsoring technical sessions: Aviation, two sessions; Applied Mechanics, two; Fuels, one; Gas Turbine Power, one; Heat Transfer, one; Hydraulic, one; Machine Design, two; Management, two; Materials Handling, one; Metals Engineering, one; Petroleum, three; Power, two; Process Industries, one; Production Engineering, one; Railroad, two; Education, one; Boiler Feedwater Studies, one; Cutting Fluids, one; Furnace Performance Factors, one. The full tentative program will appear in the May issue of MECHANICAL ENGINEERING.

As a service to members who want to hear luncheon speakers but do not want to attend the luncheons, the St. Louis Section is planning to post exact times of luncheon addresses and to provide additional seats up to the capacity of the rooms so that when the luncheons have been served, members will be able to listen to the talks in comfort.

Among the industrial plants to which inspection trips are being planned are the Venice plant of the Union Electric Company, which is a modern high-pressure steam power plant; the Wagner Electric Manufacturing Company, which manufactures small electric motors and automotive equipment; the Midwest Pipe and Supply Company, fabricators of pipe and welding fittings; Anheuser-Busch, Inc., one of the large St. Louis breweries; the McDonald Aircraft Corporation, manufacturers of jet planes and helicopters; the Western Cartridge Company, manufacturers of ammunition and explosives; and the Synthetic Liquid Fuel Plant, U.S. Bureau of Mines, Louisiana, Mo.

ASME OGP Division to Meet in Baltimore, Md., June 12–16, 1950

THE Oil and Gas Power Division of The American Society of Mechanical Engineers will hold its 22nd Annual Conference and Exhibit at the Lord Baltimore Hotel, Baltimore, Md., June 12–16, 1950. This year the Oil and Gas Power lecture series has been



MEMBERS OF THE GENERAL COMMITTEE IN CHARGE OF THE ASME 1950 SEMI-ANNUAL MEETING TO BE HELD IN ST. LOUIS, MO., JUNE 19–23, 1950

(*Front row, left to right:* Carl H. Rulfs; J. C. Parmely, chairman; Gordon R. Hughins; Conway B. Briscoe; John Buss. F. V. Hartman. *Rear row, left to right:* John Steinman; Robt. O. Slattery, treasurer; L. W. Morrell; Arthur L. Heintze; Gene Setzekorn; R. W. Merkle, vice-chairman; Harry E. Frech, Jr.; William Atchison.)

made a part of the regular Conference. A nominal registration fee will entitle a member to attend the lecture series and the regular technical sessions and to receive copies of the conference papers. While the names of the lecturers have not yet been announced, it is known that the lectures will cover various aspects of corrosion encountered in the oil and gas power industries.

The Conference will open formally on Monday, June 12, with a luncheon at which Colonel L. J. Smith, chairman of the ASME Baltimore Section will preside. The main speaker will be Walter Perkins, vice-president of the Koppers Company.

An important part of the Conference will be the annual Oil and Gas Power Exhibit in which manufacturers of Diesel engines and auxiliaries will display their latest products.

In addition to the technical sessions, the program will include a banquet and an inspection trip to the Baltimore Transit Shops, Baltimore, Md., and the Naval Engineering Experimental Station at Annapolis, Md.

The Annapolis trip will be a 2½-hour ride by boat with a luncheon on board. The return trip will be a moonlight sail up the Chesapeake Bay with refreshments, dinner, and dancing provided by the Koppers Company. This feature of the meeting which is equivalent to a $16 sight-seeing tour, will be available to members and guests for the price of $5. Wives of members will be invited to make the trip. While the members are visiting the Experimental Station, the women will visit the Naval Academy and will make a tour of historic Annapolis.

The tentative program of the conference will appear in the May issue of MECHANICAL ENGINEERING.

Four Hundred Attend 1950 ASME Machine Design Conference

Customer Influence on Machine Design Discussed

ALTHOUGH the machine-tool industry attempts to keep costs down by encouraging use of standard production machines, tool manufacturers are, nevertheless, sensitive to the demands of the customers for special designs and do incorporate customers' design suggestions. This was the concensus of 11 representatives of tool manufacturers who participated in two panel discussions sponsored by the Machine Design Division of The American Society of Mechanical Engineers and the ASME Milwaukee Section as part of the 1950 Machine Design Conference held at the Hotel Schroeder, Milwaukee, Wis., Feb. 8, 1950. Some 400 engineers attended.

In addition to the panel sessions, a luncheon program was also keyed to the theme of the meeting: "The Influence of Customer Demands and Suggestions on the Design and Performance of Capital Goods."

The speakers expressed themselves on such

THREE OF THE PANEL SPEAKERS OF THE MACHINE DESIGN DIVISION CONFERENCE

(*Left to right:* L. A. Leifer, Everett Morgan, and D. M. Pattison.)

questions as: Do customers dictate design features on the machines they purchase? Do customers' suggestions improve machines? Do you consider customers sufficiently grounded in theoretical and practical considerations to dictate design features?—and many others.

Suggestions Often Improve Designs

Orders of special equipment by a customer often become apparent in the long-term development of new and improved models for general sale, the speakers agreed. It is quite true, they emphasized, that the modifications requested by customers often improve performance, efficiency, reliability, and safety of a product. However, the flexibility of equipment may not necessarily be improved. In many large plants a machine is required for straight line production on one task. Some machines designed for smaller firms may be required for several tasks.

The speakers said that while manufacturers always are agreeable to discussing product changes with customers, the average manufacturer will attempt to maintain a standard machine in production until customers' wants or new technical developments dictate changes.

Some speakers said that what customers want is not always economical or efficient. The manufacturer will produce the equipment only after properly warning the client of limitations. The manufacturer must rely on customers for reports on operation and efficiency of machines. From such suggestions come ideas on maintenance, repair, safety, and effectiveness, they said. Some speakers complained they never hear from their customers.

It was generally agreed that if a new idea is to benefit one customer only and was suggested by him, the patent search should be made by him. However, if the manufacturer can use the idea on other models, his firm should stand patent-search expense.

Panel Speakers

Panel speakers were: *Afternoon session*—Everett Morgan, manager of engineering, Giddings and Lewis Machine Tool Company, Fond du Lac, Wis.; L. A. Leifer, assistant chief engineer, Gisholt Machine Company, Madison, Wis.; Swan E. Bergstrom, vice-president, Cincinnati Milling Machine Company, Cincinnati, Ohio; Gunnard Olson, sales manager, Ingersol Milling Machine Company, Rockford, Ill.; D. M. Pattison, vice-president, Warner and Swasey Company, Cleveland, Ohio.

Evening session: William C. Johnson, vice-president, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.; P. S. Stevens, chief engineer, Bucyrus-Erie Company, South Milwaukee, Wis.; Fred Salditt, vice-president, Harnischfeger Corporation, Milwaukee, Wis.; Roland W. Bayerlein, vice-president, Nordberg Manufacturing Company, Milwaukee, Wis.; A. M. Fisher, district manager, Westinghouse Electric Corporation, Pittsburgh, Pa.; D. N. Inman, service manager, Westinghouse Electric Corporation, Pittsburgh, Pa.

Speaking at the luncheon, J. B. Armitage, director at large, ASME, and vice-president, Kearney and Trecker Corporation, Milwaukee, Wis., pointed out that the "great wealth of new processes and materials" developed during the war were finding applications almost daily in American industry.

Work on many World War II developments

was not yet finished, Mr. Armitage said. It was the duty of engineers and management designers to consolidate new developments and apply them to peacetime uses. He referred specifically to the gas turbine, the turboprop and jet aircraft, and a group of new alloys many of which had not yet been applied to peacetime uses.

Applied Mechanics Division to Hold 1950 Conference at Purdue University

THE 1950 Annual Conference of the Applied Mechanics Division will be held at Purdue University, Lafayette, Ind., June 22–24, 1950.

Ten of the papers to be presented at the conference have already been set in type and preprinted and may be obtained by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Preprint numbers and titles of these papers are:

50—APM-1 "An Iterative Numerical Method for Nonlinear Vibrations"

50—APM-2 "Transverse Vibration of a Two-Span Beam Under the Action of a Moving Alternating Force"

50—APM-3 "The Stresses Around a Small Opening in a Beam Subjected to Pure Bending"

50—APM-4 "Elastic Torsion in the Presence of Initial Axial Stress"

50—APM-5 "Temperature Distribution in a Steady Laminar, Preheated Air Jet"

50—APM-6 "Effect of Stress-Free Edges in Plane Shear of a Flat Body"

50—APM-7 "Torsion of a Circular Shaft With a Number of Longitudinal Notches"

50—APM-9 "Torsional Stress Concentration in Angle and Square Tube Fillets"

50—APM-10 "The Use of Skewed Rolls in Calendering Operations"

50—APM-11 "Characteristics of Irrotational Flow Through Axially Symmetric Orifices"

The full tentative program of the Conference will appear in the May issue of MECHANICAL ENGINEERING.

Actions of the ASME Executive Committee

At a Meeting at Headquarters Feb. 16, 1950

A MEETING of the Executive Committee of the Council was held in the rooms of the Society, Feb. 16, 1950. There were present: Forrest Nagler, presiding; F. S. Blackall, jr., A. C. Pasini, and Ralph A. Sherman of the Executive Committee; H. E. Martin (Organization Committee); E. G. Bailey, past-president; A. R. Mumford, vice-president; E. J. Kates, assistant treasurer; C. E. Davies, secretary; and Ernest Hartford, executive assistant secretary.

Metals Engineering Handbook

A contribution was approved from the Development Fund to cover cost of editorial and mechanical phases of preparing the Metals Engineering Handbook for publication.

Custodian Funds

The appointment of a committee composed of the following: Ralph A. Sherman, Board on Technology; Charles W. Good, Professional Divisions; T. A. Marshall, Management Division; a representative of the Finance Committee; and a representative of the Research Committee, was authorized to study the entire question of custodian funds for clarification of present practice and a statement of Society policy.

Company List of Members

Publication of a company list of ASME members for membership-development purposes was approved. An edition of the list to sell for $1 is also being considered.

Informal Council Meeting

The Board on Membership was invited to prepare topics for discussion at an informal meeting of the Council to be held during the Spring Meeting in Washington, D. C.

International Standards Program

While the Society is currently participating in such international standardization projects as Screw Threads, Limits and Fits, Graphical Symbols, and others, and while the Joint Code Committee has been authorized to assume the secretariat of an International Standardization Organization project, no provision has been made for expenses incurred in these activities. To solve this problem, the Board on Codes and Standards was encouraged to determine whether the money required for the international standardization activity can be raised from industry.

Rice Lecturers

In order to give substantial recognition to Calvin W. Rice Lecturers, it was voted to adopt the policy of conferring life membership on all Rice Lecturers, members as well as nonmembers. In accordance with the new policy, life membership was conferred on Hilding Tornebohm of Sweden, who became a member in 1937.

Certificate of Award

Upon recommendation of Arthur Roberts, Jr., vice-president, ASME Region IV, a Certificate of Award was granted to Mebane E. Turner, retiring chairman of the Piedmont-Carolina Section.

Inter-Society Conference

The following recommendations, agreed upon by the Inter-Society Conference on Engineering Student Chapters at its meeting of Jan. 27, 1950, were approved and referred to the vice-presidents for comment:

1 That student engineering organizations should be utilized to promote unity and professional consciousness among the students.

2 That at each college which does not have some organized co-ordination of engineering student groups there be formed a council or local society to advise and co-ordinate such groups.

3 That new engineering student activities be carried on by expansion and co-ordination within existing groups so far as practicable.

4 That there be prepared a set of general recommended principles regarding operation of engineering student societies for the guidance of college administrators.

5 That there be formulated a program of typical desirable activities for student engineering groups.

6 That student members of all approved student engineering groups be considered eligible upon graduation for membership in the national engineering organizations, without payment of an admission fee.

London Conference

Upon recommendation of the secretariat at the Conference of Engineering Societies of Western Europe and the United States of America, the following methods, which were proposed as a means of achieving liaison among Conference members, were approved:

1 The establishment of the Advisory Council of Conferences of Engineering Societies consisting of the Conference of Western Europe and the United States of America; the Conference of Commonwealth Engineering Institutions, and other conferences of a similar character when established.

2 The individually participating (regional) conferences would continue to conduct their affairs on a regional basis, but would agree on joint interchanges of their individual resolutions, recommendations, and the like, and of the necessary supporting documents, if any.

3 For the purpose of maintaining a continuous liaison in intervals between meetings of the individual (regional) conferences, the British engineering institutions could act as a natural bridge between the Western European and the Commonwealth Conferences; the Engineers Joint Council would act in a similar manner for the Western European Conference and any corresponding conference set up in the Americas.

4 Plenary meetings of the Advisory Council of Conferences of Engineering Societies would be possible if the need arose; but it seems probable that any common viewpoint could normally be established by correspondence, the close liaison already existing between the British and American Institutions acting as a useful informal link in securing final co-ordination between the individual (regional) conferences.

French Society of Civil Engineers

It was voted to extend the privileges of membership of the ASME without charge to the secretary of the French Society of Civil Engineers, provided that the same privileges in the French Society are extended to the Secretary of the ASME.

Appointments

The appointments on committees and joint activities recommended by the Organizations Committees were approved.

The presidential appointment of Alex D. Bailey to represent the ASME at the 1950 Washington Award Committee Dinner was also approved.

ASME Junior Forum

Compiled and Edited by a Committee of Junior Members

The Young Engineer's Leisure Time

EFFECTIVE use of leisure time is one of the most important day-by-day decisions which we as junior engineers have to make. The value of our leisure time presents a striking contrast with our vocational hours. Our time is of relatively low value to our employer when we first start working, but it increases, if we are on our toes, as experience increases.

Our leisure time is of more value to us in starting out than in any other period in our lifetime. We have the training and education to learn from our leisure-time experience, and every valuable lesson will earn interest for us during the rest of our lives.

Leisure time in this portion of our lives should not be taken for granted or treated without planning or purpose. For a young man who has spent several thousand dollars' worth of money and two or three times as much value in time in securing an education to prepare himself for a professional career, haphazard attention to such an important part of his development is foolish. In our present era we lay great stress upon the attainment of a degree representing the completion of a prescribed curriculum. Yet, if we judge from the remarkable men who have little formal education, we are brought to the realization that a man without the benefit of a college education who reads well is better educated and more competent than the bachelor of arts or science who stops his learning process in the classroom.

Leisure-Time Activities

Let us consider briefly some of the activities which demand our leisure time. I will take the liberty of presenting some personal views with which you may find reasonable disagreement but which may help you to come to some personal decisions. I would classify leisure-time activities under three headings: recreation, intellectual development, and social development.

Under the heading of recreation, I would include such activities as movie attendance, bridge playing, skating, skiing, hunting, dancing, smokers, and craft work. The amount of time which can be spent effectively in this type of activity is difficult to analyze. Large blocks of time can be spent on recreation with little physical, mental, or social gain. It seems to me that relaxing activity should offer something sufficiently different from our day-by-day work so that we will be refreshed and invigorated. In recreation, as in everything else, we cannot afford to spend much of our valuable time in being amused. Unless we become a part of our activity we do not gain much advantage from it.

I consider that there is much to be said for athletic activities which cleanse our systems and invigorate us. There is much to be said for hobbies such as music, dancing, photography, art, and craft work because of the inspiration which comes from beautiful things and because of the feeling of accomplishment which they yield. A good hobby can do wonders in the way of soothing a particularly trying day or in making bearable a difficult or tedious job which must be completed. These hobbies are of much greater interest and value if actively participated in rather than passively enjoyed, and as I discuss later, should if possible be of such a type that all the family may participate. I, personally, get great pleasure from repairing and working on an old house and keeping its grounds and garden in order. As far as I am concerned, not much can be said for movie going, witnessing athletic contests, or night clubbing, unless in the company of unusually stimulating persons. We should not overlook, however, the importance of some recreation. There is a certain amount of poise and ease of manner which can be gained only by meeting other people informally on a friendly basis.

Intellectual Development

As young engineers we must be careful to give proper attention to our intellectual development lest we become too narrow to handle adequately a position for which we might be considered. This includes professional development, which may take the forms of (1) extension courses at night or correspondence schools; (2) technical reading on the more advanced fringes of our professional work in texts and scientific magazines; and (3) preparation of papers for submission at technical meetings.

Probably one of the most important habits for the young engineer to develop is that of reading good literature. We all of necessity have specialized in our studies and therefore have not given as much attention as we should to the broadening studies which every educated man requires. Studies in history, philosophy, foreign literature, and the masterpieces of our English literature are necessary for any educated man. In this regard, the finding of the Human Engineering Laboratories that all good executives possess the one common characteristic of a large vocabulary, is significant. A forceful and rich use of language requires a study of language artistically, forcefully, and effectively used.

I, personally, am very weak in my reading, for although I enjoy reading I have organized my time so poorly that I never find an opportunity to read the classics of our language. To develop breadth of interest and to become educated citizens we should follow the current events with a determination to find the facts but to use our engineering judgment to draw our independent conclusions. For example, I find the magazine, *Time*, allows me to keep abreast of the news but that the newspaper, *Christian Science Monitor*, presents a much better basis for forming an opinion as to actions to be taken with regard to the problems facing us. Lastly, in our reading we should familiarize ourselves with other sciences than our own. Biology, botany, psychology, and astronomy are interesting and will be found to have numerous applications to our specialized branch. If you enjoy walking, the pleasures which you can get from combining hiking with botany, biology, geology, local history, or forestry are boundless.

Social Development

The demands of social development secure inadequate attention from many engineers. This complicated world has gained much in material things but the most important element in its continued existence is how we as individuals and nations get along. Our material development has been possible only because a social system is in existence which provides the means for specialization and co-operation. There are indications that our social development is more gradual than the rapid expansion of scientific and engineering knowledge and for stability, must be accelerated to keep pace. For example, recently the whole country suffered because of a costly disagreement in the steel industry. A more enlightened and co-operative social philosophy would indicate that both industry and labor have a responsibility to the country which gives them their business and their jobs and that more can be gained by both when they work to improve the efficiency of the whole steelmaking operation. Also, we must realize that our own self-interest demands that large variation in standards of living both in our own country and in the world should be avoided because such conditions lead to hatred and violence, and eventually to war, waste, and degradation for all. Our forefathers have left for our use a wonderful heritage—consider the schools and colleges, the wealth of literature, the public buildings and hospitals, the mechanical plant, and the transportation systems. We have no right to settle back and take these for granted but must do our part to add some for our successors and to make them available to our neighbors.

Civic Responsibility

This social aspect of our lives requires that we give our children an education, an appreciation of their heritage and of the beauty which surrounds them, and an enthusiasm for the future and the development of the human race. This is a personal charge upon us which we cannot transfer to professional educators or anyone else. If the originality and individual independence upon which our nation is built are to survive, we must accept this demand upon our valuable leisure time.

Our diminishing leisure time has, however, more than this family demand on it. Our community needs our encouragement and, I am bold to believe, more of the factual, matter of fact, and analytical type of thinking, which our engineering work has developed. Also, the matter of the philosophy which guides the direction in which our activities move is one of the most important. The area which is involved in setting the ideals of our living, our religion, as represented socially in our churches, must have not only our financial support but the fullest measure of our intellectual activity. We have no right to isolate ourselves from our Christian brothers on the basis of disbelief but we must actively search for and demand some basis for living which will adequately give us the confidence, ideals, and purpose which we all need to guide our lives.

As our economy develops to give us higher standards of living and more leisure time, we must realize that only a small portion of this time is available for play. The social system which yields these results becomes increasingly complex and demands an intelligent understanding of its workings. We must accept this responsibility.

By F. EVERETT REED, member, National Junior Committee

ASME Calendar

of Coming Events

April 12–14
ASME Spring Meeting, Hotel Statler, Washington, D. C.

April 24–26
ASME Process Industries Division Conference, William Penn Hotel, Pittsburgh, Pa.

June 12–16
ASME Oil and Gas Power Division Conference, Lord Baltimore Hotel, Baltimore, Md.

(Final date for submitting papers was Feb. 1, 1950)

June 19–23
ASME Semi-Annual Meeting, Hotel Statler, St. Louis, Mo.

(Final date for submitting papers was Feb. 1, 1950)

June 22–24
ASME Applied Mechanics Division Conference, Purdue University, Lafayette, Ind.

(Final date for submitting papers was Feb. 1, 1950)

Sept. 18–22
ASME Instruments and Regulators Division Conference, Municipal Auditorium, Buffalo, N. Y.

(Final date for submitting papers—May 1, 1950)

Sept. 19–21
ASME Fall Meeting, Hotel Sheraton, Worcester, Mass.

(Final date for submitting papers—May 1, 1950)

Sept. 25–27
Petroleum Mechanical Engineering Conference, Hotel Roosevelt, New Orleans, La.

(Final date for submitting papers—May 1, 1950)

Oct. 23–25
ASME Fuels Division Conference, Hotel Statler, Cleveland, Ohio

(Final date for submitting papers—July 1, 1950)

Nov. 26–Dec. 1
ASME Annual Meeting, Hotel Statler, New York, N. Y.

(Final date for submitting papers—Aug. 1, 1950)

(For Meetings of Other Societies see page 352)

Alfred Noble Prize

NOT many ASME junior members are aware of it, but there is a fat plum of a prize offered each year which makes easy picking for the man who knows what he is about.

The prize is the Alfred Noble Prize made annually to an author of a technical paper published in any one of the journals of the Founder Societies (ASCE, AIME, ASME, and AIEE) and the Western Society of Engineers, who has not passed his thirty-first birthday.

The prize is worth going after because in addition to a certificate and helpful publicity in the technical press, the recipient is given a cash award of about $350. His expenses incurred in the acceptance of the prize are also paid.

Because the candidates for the prize are not numerous the chances of any one paper winning the award are good. For some reason ASME members have not fared too well as recipients. Since the prize was established in 1929, only three ASME members have won it as against four for AIME, seven for AIEE, and two for ASCE.

Each year a substantial number of papers presented before the ASME are written by junior members. For example, at the 1949 Annual Meeting, 38 of the 200 papers presented were by authors who were listed as juniors. It is likely that some of the papers will be published either in Transactions, *Journal of Applied Mechanics*, or MECHANICAL ENGINEERING, and that the authors will become eligible for the prize. But even so, no matter how good the paper is, the author cannot qualify as a candidate for the prize unless some other person or group recognizes its merits and recommends it to the Selection Committee. Here is where the National Junior Committee can help some deserving junior. All junior members are urged to keep the Alfred Noble Prize in mind when reading ASME publications. If, in your opinion, the paper by a junior is worthy of the prize, please tell the National Junior Committee about it.

ASME Standards Workshop

MANUFACTURERS of woodworking machinery using circular saws and cutters responded favorably to a survey conducted recently by the ASME Wood Industries Division to determine whether the wood industry could benefit by a reduction in the number of arbor sizes now on the market. A questionnaire sent to 164 machinery manufacturers was returned by 53 per cent of the companies. Replies confirmed the need for standardization in arbor-saw-diameter relationships, some 280 of which were reported to be in use by 64 manufacturers of wood-cutting equipment.

This survey will be the subject of discussion at a Wood Industries session at the ASME Spring Meeting, Washington, D. C., April 12–14. A report of the Division's Subcommittee on Wood Cutting Tools and Equipment will recommend appointment of an industry-wide committee to carry on the project.

* * *

INITIATIVE on the part of the Hydraulic Committee of the ASME Southern California Section has resulted in proposals now before the Board on Codes and Standards for two new standardization projects—the first on design practices for penstocks and the other on design practices for taintor and lift gates. What is sought are statements of good practice which can be used by designers to arrive at acceptable designs. The proposed projects seek to incorporate latest developments in the design of mechanical equipment for dams into standard practices useful to engineers interested in this field.

EXPERIENCE with cost-cutting abilities of quality-control techniques on the part of many members is giving impetus to reactivation of the Joint Committee on Statistical Applications in Engineering and Manufacturing. Organized in 1929, this Committee has been instrumental in the development of many quality-control techniques before and during the last war. Many tasks await the reactivated Committee. Among these are: (1) To seek new fields for application of statistics in industry, and (2) to develop new techniques to master the resulting problems.

A SUBGROUP of Subcommittee 9 of the Sectional Committee on Pipe and Pipe Fittings B16 met on January 25 to discuss standards for mechanical-joint tube fittings and to name liaison representatives to work with subgroups of Sectional Committee B31 of Pressure Piping currently working on a major revision of the 1942 edition of the Code for Pressure Piping.

REVISION of pressure-temperature tables for American standard steel pipe flanges and fittings for use in a forthcoming revision of

American Standard B16e-1939 and its supplement was taken up by a subgroup of Sectional Committee B16 at a meeting on March 9.

THIRTEEN ASME sponsored standards are currently with the American Standards Association awaiting approval as American Standards. Ten others are in the final stages of completion with sponsors, or sectional committees, or are being reviewed by interested parties.

Fuels Division Joins in Smoke-Control Event

THE Fuels Division of The American Society of Mechanical Engineers is sponsoring a technical session at the 1950 annual conference of the Smoke Control Association of America to be held at the Mount Royal Hotel, Montreal, Canada, May 21–25, 1950.

The Association includes among its membership air-pollution-control officials of various municipalities in the United States and Canada, federal and state health officials, and engineers representing various segments of American industry.

The ASME session is scheduled for Wednesday morning, May 24. The following papers will be presented:

"Unsolved Problems in Air-Pollution Control," by H. B. Lammers, chairman, Coal Producers Committee for Smoke Control, Cincinnati, Ohio.

"Testing for Fly Ash Emission by the Small Boiler Plant," by Philip F. Best, chief mechanical engineer, Thermix Corporation, Greenwich, Conn.

"Fly Ash Collectors for Small Boiler Plants", by J. L. Schuman, Buell Engineering Company, Inc., New York, N. Y.

Other technical sessions dealing with various problems of air-pollution control will be sponsored by The National Association of Power Engineers, American Society of Heating and Ventilating Engineers, American Industrial Hygiene Association, Manufacturing Chemists' Association, and The Institute of Power Engineers (Canada).

1950 Power Show to Be Under ASME Auspices

ANNOUNCEMENT was recently made that the 19th National Exposition of Power and Mechanical Engineering will be held under the auspices of The American Society of Mechanical Engineers. It will be at Grand Central Palace, New York, N. Y., Nov. 27–Dec. 2, 1950, and will be held at the same time and in conjunction with the ASME Annual Meeting.

Since the inception of the Power Show in 1922, ASME has always co-operated with the Exposition and has had a booth in a prominent location near the main entrance to the Exposition. This year, however, is the first time that the Power Show is being held under the auspices of ASME.

Management of the Exposition remains as in the past in the hands of the International Exposition Company, who also manage the International Heating and Ventilating Exposition, the Exposition of Chemical Industries, and the Electrical Engineering Exposition. Permanent headquarters are at Grand Central Palace, New York, N. Y.

Fewer Technical Sessions at 1950 Annual Meeting Sought

INCREASING size of the Annual Meetings of The American Society of Mechanical Engineers has introduced a problem of management which is currently occupying the attention of the ASME program-making agencies.

A glance at the statistics for the 1949 Annual Meeting reveals what a tremendous operation such a meeting is. Some 73 technical sessions, 13 luncheons, and two dinners were held. At 43 of the sessions two papers were read and discussed; at 29 sessions 3 papers were presented; at 8 sessions 4 papers were discussed. One session had 5 papers and one had as many as 8 papers. In all, 200 papers and eight talks were on the program. Of these, 137 were preprinted in advance of the meeting and were made available to members who wished to purchase copies. On two occasions members had to choose between as many as nine simultaneous sessions.

For the 1950 Annual Meeting the Meetings Committee is aiming for a program of 65 sessions. This will make it possible to limit simultaneous sessions to five at any one period and thereby reduce the likelihood that the two or three sessions of primary interest to any one member will be scheduled at the same hour. Papers of high quality will be given first consideration by the program makers.

ASME Sections

Coming Meetings

Arizona: April 22. Spring Section meeting at Phoenix, Ariz. Meeting will be held with senior students if their annual field trip brings them to Phoenix.

Baltimore: April 24. Engineers Club of Baltimore, 6 W. Fayette Street. Cocktails at 6 p.m., dinner at 6:30 p.m. and Section meeting at 8 p.m. Subject: To be announced. Speaker: H. L. Dryden. Sponsor: H. Hollerith, Jr.

Cleveland: April 13. Cleveland Airport, 2:30 p.m. Inspection tour: Lewis Flight Propulsion Laboratory of NACA.

Detroit: April 11. Industrial Relations Meeting. Rackham Memorial Building.

Erie: April 6. Arlington Hotel, Oil City, Pa., 6:30 p.m. A joint dinner meeting with Northwestern Pennsylvania Society of Engineers. Subject: General Motors Torque Converter, by R. M. Schaefer.

Iowa-Illinois: April 25. University of Iowa Memorial Union, Iowa City, Iowa. Dinner at 6:30 p.m. Three ASME student members from the department of mechanical engineering, State University of Iowa, will present their papers which were chosen as the best in the Student Paper Competition.

Metropolitan Section: April 11. Joint Meeting, Engineers' Forum, Power and Fuels Division, Room 1101[1] at 7:30 p.m. Subject: Natural Gas and Competing Fuels, by Frederick Crabbe, Harold Birkett, and E. H. Codding.

April 13. Management Division, Room 502[1] at 7:30 p.m. Subject: Opportunities for Engineers in Management, by Harold Engstrom.

April 13. Woman's Auxiliary, Engineering Woman's Club, 2 Fifth Avenue. Luncheon at 12:30 p.m., followed by showing of nylon tricot lingerie presented by Vanity Fair Mills, Inc.

April 19. Spring Round-Up, Hotel Statler. Cocktail Hour 6 p.m. to 7 p.m. Dinner at 7 p.m., followed by entertainment.

April 25. New Jersey division plant visit to Hyatt Bearing Division, General Motors Corporation, Harrison, N. J. Luncheon served in plant cafeteria at 12 noon, tour starting at 1 p.m.

April 27. Engineers' Forum, Room 502[1] at 7:30 p.m. Subject: Human Relations—Key to Production, by Charles E. Carll and Morehead Patterson.

Plainfield: April 19. Elks Club, Elizabeth, at 8:15 p.m. Subject: The Nuclear-Energy Field, by A. L. Baker.

Southern California: April 12. Science Building 107, University of Southern California at 7:30 p.m. Subject: Gate, Globe, Angle, and Check Valves, by G. E. Benesch.

April 19. Mechanical Engineering Building, California Institute of Technology, Pasadena at 7:30 p.m. Subject: Writing Specifications for Mechanical Equipment, Second Class, by A. Hunter.

April 25. Institute of the Aeronautical Sciences Building, 7660 Beverly Boulevard, Los Angeles, Calif. at 6:30 p.m. Subject: Newer Trends in Engineering, by L. M. K. Boelter.

Southern Tier: April 24. Section meeting, Ithaca, N. Y. Ladies' Night. Subject: Home Freezing. Speaker to be announced.

Section Activities

REPORTS of the following ASME Section Meetings were received recently at headquarters.

Akron-Canton, Feb. 16. Speaker: Waldemar Naujoks. Subject: Modern Forging Techniques. Attendance: 43.

Atlanta, Feb. 24. Speaker: Allen Gowdy. Subject: Procedure Welding. Demonstration, conference, exhibits, and slides on procedure welding of high-pressure piping. By G. W. Hauck and Eric Seabloom. Attendance: 65.

Baltimore, Feb. 27. Speaker: O. de Lorenzi. Subject: Methods for Burning Liquid and Gaseous Fuels. Attendance: 151.

Boston, Feb. 23. Speakers: B. C. Mallory and F. W. Argue. Subject: Basic Factors of Steam Power Station Design. Attendance: 304.

Central Iowa, Feb. 14. Joint meeting with Mechanical, Electrical, and Railway Section

[1] Engineering Societies Building, New York, N. Y.

of Iowa Engineering Society, Iowa Section of AIEE, and Iowa Section, ASHVE. Speakers: J. M. Drabelle and Wayne Gasper. Subjects: Centralized Control of Western Power Station; and Problems of Production Process Control in the Manufacture of Home Laundry Equipment. Attendance: 100.

Central Pennsylvania, Feb. 15. Speaker: C. F. Kottcamp. Subject: Gas Turbines and Fuels. Attendance: 120.

Cincinnati, Feb. 23. Joint meeting with Cincinnati Section, AIEE. Speakers: H. R. Burns, E. H. Mitsch, and G. E. Heidenreich, Sr. Subject: Miami Fort Station Unit No. 5 Addition. Attendance: 175.

Cleveland, Feb. 9. Speaker: G. V. Woodling. Subject: How to Go Into Business With a Patented Product.

Feb. 16. Inspection tour: 90,000-kw generator, turbine, and boiler plant addition at C. E. I. Avon Lake Station.

Feb. 23. Discussion leader: P. T. Angell. Subject: Vibrations.

East Tennessee (Oak Ridge Group), Feb. 15. Speaker: W. L. Cisler. Subject: Use of Atomic Energy in the Power Field. Attendance: 175.

East Tennessee (Upper East Tennessee Group), Feb. 6. Speaker: James Evans. Subject: Hospital Services. Attendance: 27.

Erie, Feb. 16. Speaker: A. L. Terlouw. Subject: Functional Photography. Attendance: 193.

Iowa-Illinois, Feb. 28. Joint dinner meeting with Muscatine Engineers Club. Inspection trip: soybean plant, Muscatine Processing Corporation. Attendance: 62.

Kansas City, Feb. 13. Speaker: J. T. Rettaliata. Subject: Gas-Turbine Power Development. Attendance: 118.

Ontario, Feb. 9. Speaker: R. G. Alison. Subject: Arc Welding in Machine Construction. Attendance: 65.

Feb. 16. Conducted tour of all manufacturing phases from foundry to shipping in the plant of the Anaconda American Brass Ltd. Attendance: 72.

March 2. Conducted tour of testing and standards laboratories of the Hydro Electric Power Commission and Canadian Standards Association Laboratories. Attendance: 47.

Philadelphia, Jan. 24. Speaker: A. C. Monteith. Subject: Development of the Engineer. Attendance: 150.

Wilmington Subsection, Feb. 15. Speaker: H. V. Menking. Subject: Aluminum and Its Application in Industry. Attendance: 95.

Piedmont-Carolina, Feb. 16. Speaker: M. C. Miller. Subject: Corrosion. Attendance: 60.

Pittsburgh, Feb. 21. Speaker: W. L. Kraus. Subject: The Design and Operation of Heat-Pump Air Conditioners. Attendance: 75.

Rocky Mountain, Feb. 16. Speaker: O. de Lorenzi. Subject: Methods of Firing Pulverized Coal and Recent Developments in Burning Wet Wood. Attendance: 53.

St. Louis, Feb. 24. Speaker: G. C. Cooper. Subject: Design of New High-Pressure Gas Transmission System. Attendance: 90.

Schenectady, Feb. 16. Speaker: Stephen Joseph. Subject: Private Investment and Progress. Attendance: 40.

South Texas, Feb. 17. Speakers: A. Y. Gunter and Prof. C. Short. Subject: Heat Transfer in Heat Exchangers. Attendance: 114.

Youngstown, Feb. 9. Speaker: T. L. White. Subject: Effects of Some Fabricating Processes on Steel. Attendance: 60.

Feb. 23. Speaker: John Wilbur. Subject: Combustion Controls. Attendance: 135.

Student Branch Activities

REPORTS of the following ASME student branch meetings were received recently at Headquarters:

University of Akron, Feb. 23. Business meeting. Attendance: 14.

Alabama Polytechnic Institute, Feb. 13. Speaker: C. Stringfellow, student. Subject: Grading System of Instructors. Attendance: 35.

Feb. 27. Speaker: Colonel Stark. Subject: Public Relations Between Student and Industry. Attendance: 42.

Brown University, Feb. 9. Subject: S. Withington. Subject: Railroading—Its Problems, Solutions, Progress. Attendance: 35.

Bucknell University, March 2. Speaker: C. R. Scott, Jr. Subject: Production Planning and Control.

Clemson A and M College, Feb. 21. Election of officers. Attendance: 30.

Colorado A and M College, Feb. 15. Speakers: Messrs. Throne, Parce, and Dalquist. Subject: What Industry Expects of the Graduating Engineer. Attendance: 120.

University of Connecticut, Feb. 21. Speaker: F. M. Gunby, vice-president, ASME Region I. Subject: Professional Engineering. Attendance: 50.

Cornell University, Feb. 16. Speaker: M. S. Krotz. Subject: Recent Developments and Applications of Rubber. Attendance: 35.

University of Delaware, Feb. 27. Speakers: Students Fox, Ryan, Veasey, McGee, Hoffecker, Luckens, and Trimble. Subject: Contest for the presentation of student papers. Attendance: 58.

University of Detroit, Feb. 2. Speaker: C. Schneider. Subject: Industrial Relations. Attendance: 90.

Duke University, Feb. 21. Film: The Story of Formica. Attendance: 38.

George Washington University, Feb. 6. Speakers: Students S. Fineblum, R. Volin, H. Goswell, and N. Chacos, in student-speaker competition. Attendance: 50.

University of Illinois (Navy Pier Division) Feb. 1 to 9, inclusive. Inspection trips to plants of Griffin Wheel Company, Wisconsin Steel Company, The Peoples Gas Light and Coke Company, and National Malleable and Steel Casting Company. Attendance: 35.

State University of Iowa, Feb. 8. Election of officers for second term. Attendance: 102.

Feb. 15. General business meeting. Attendance: 102.

Feb. 22. Speaker: Dean Dawson. Subject: Employment Outlook for Engineers. Attendance: 132.

Iowa State College, Jan. 23. General business meeting. Speaker: J. Kolls. Subject: Engineering and Management in a Small Business. Attendance: 35.

Johns Hopkins University, Feb. 13. Speaker: Abel Wolman. Subject: The Legal Aspects of Engineering. Attendance: 35.

University of Kansas, Feb. 8. Election of officers and business meeting. Speaker: John Robb. Attendance: 45.

Feb. 15. Speaker: John Hughes. Subject: Armstrong Steam Traps. Attendance: 100.

Kansas State College, Feb. 9. Speaker: Carl Tjerandsen. Subject: Institute of Citizenship, Its Function, Organization, and Purposes. Attendance: 334.

March 2. Business meeting. Attendance: 123.

University of Kentucky, Feb. 16. Speaker: Dr. Lyle Croft. Subject: Proper Procedure of Application Letter Writing. Attendance: 200.

Lafayette College, Feb. 16. Speaker: P. M. Hummer. Subject: Careers in Sales Engineering. Attendance: 90.

Louisiana Polytechnic Institute, Feb. 7. Business meeting. Attendance: 18.

Feb. 21. Business meeting. Attendance: 32.

University of Louisville, Feb. 16. Film: Wrought Iron. Attendance: 110.

University of Maine, Feb. 15. Speaker: Mr. Gehring. Subject: Precision Measurements. Attendance: 32.

University of Michigan, Feb. 22. Films: Alloy Steels and Wrought Iron. Attendance: 90.

Michigan College of Mining and Technology, Feb. 21. Film: Niagara on Wheels. Attendance: 54.

Feb. 23. Speaker: K. B. McEachron, Jr. Subject: Function of Engineering in Industry. Attendance: 79.

Michigan State College, Feb. 15. Speaker: J. J. Edwards. Subject: Methods Engineering. Attendance: 72.

University of Minnesota, Jan. 25. Business meeting. Attendance: 27.

Feb. 8. Program: Talk and demonstration of IC engine testing components by the Harry Halington Company. Attendance: 125.

Mississippi State College, Feb. 3. Speaker: A. Roberts, Jr., vice-president, ASME Region IV. Attendance: 41.

Feb. 23. Speaker: Mr. Carpenter. Subject: Water Supply. Attendance: 28.

University of Missouri, Feb. 8. General business meeting. Attendance: 55.

Missouri School of Mines and Metallurgy, Feb. 8. Speakers: Messrs. Hartman, Frech, Bryan, and Boyles. Subject: Job Procurement. Attendance: 109.

Feb. 23. Speaker: Frank Wodtke. Subject: Opportunity for College Graduates in Machine Design. Attendance: 85.

University of Nebraska, Feb. 1. Speaker: M. Russell. Subject: ASME Annual Convention in New York, N. Y. Attendance: 62.

Feb. 16. Speaker: Prof. L. S. Whitson. Subject: Engineering Economic Analysis—the Basis of Decisions. Attendance: 81.

University of Nevada, Jan. 18. Speaker: Dr. Harris. Subject: The Progress in the Recording of Music. Attendance: 19.

University of New Hampshire, Feb. 6. Film: Indian Paint—depicting the manufacture of wire rope. Attendance: 61.

Feb. 13. Speaker: Mr. Miller. Subject: How to Get a Job. Attendance: 53.

College of the City of New York, Feb. 9. Speaker: F. P. Burns. Subject: How to Help Yourself Through the ASME. Attendance: 85.

Feb. 16. Films of General Motors Company; Progress Through Engineering, and Quality in the Making. Attendance: 60.

New York University (Evening Division) Jan. 3. Speakers: A. Mumsen and G. Asch. Subject: Heating and Air Conditioning. Attendance: 20.

(Day) Feb. 14. Speaker: Mr. Chapman. Subject: Hardening of Metals. Attendance: 41.

North Carolina State College, Jan. 17. Speaker: Prof. L. L. Voughan. Subject: Trends in Engineering Education. Attendance: 28.

North Dakota Agricultural College, Jan. 31. Short talks by students R. F. Anderson, John Sigurdson, and Thomas Nowak. Film: A Letter to a Rebel. Attendance: 30.

Feb. 21. Speaker: Prof. C. Schmidt. Subject: Jobs and Job Placement. Attendance: 37.

University of North Dakota, Feb. 14. General business meeting. Attendance: 36.

Northwestern University, Jan. 31. Two films: Winter Wonderland, and Flying to Guatemala. Attendance: 38.

Feb. 7. Speaker: Walter Buerckel. Subject: Files. Attendance: 42.

Feb. 21. Election of officers. Attendance: 45.

Feb. 23. Speaker: J. Vernon. Subject: Sales Engineering as a Career for Technical Men. Attendance: 240.

Norwich University, Feb. 8. Election of officers. Speaker: Professor Emerson. Attendance: 28.

Feb. 22. Film: Operation of the Lathe. Attendance: 17.

University of Pennsylvania, Feb. 15. Joint ASME-ASTE meeting. Speaker: John Whitesell. Subject: Tooling in Industry. Attendance: 67.

Polytechnic Institute of Brooklyn, Feb. 14. Speaker: H. S. Rogers. Subject: The Engineering Council for Professional Development. Attendance: 52.

Pratt Institute. Feb. 15. General business meeting. Attendance: 38.

Princeton University, Feb. 8. Business meeting of film on jet propulsion: MacDonald Phantom. Attendance: 30.

Rensselaer Polytechnic Institute, Dec. 6. Speaker: J. B. Wilkie. Subject: Quality Control With Modern Gaging Practice. Attendance: 66.

University of Rochester, Feb. 9. Joint meeting with Rochester junior branch. Subject: Design and Development Engineering. Attendance: 37.

Feb. 16. Joint meeting with Rochester junior branch. Subject: Industrial Engineering. Attendance: 38.

Feb. 23. Joint meeting with Rochester junior branch. Subject: Sales Engineering. Attendance: 37.

Rutgers University, Feb. 17. Speaker: Professor Besley. Attendance: 23.

March 2. Two films, parts 1 and 2: ABC of Automobile Engines. Attendance: 64.

University of South Carolina, Feb. 7. Business meeting. Attendance: 39.

Feb. 21. Speaker: E. Williams. Subject: The Need for Close Scrutiny of Your Individual Social and Political Beliefs. Attendance: 60.

South Dakota State College, Feb. 15. General business meeting. Attendance: 22.

University of Southern California, Feb. 17. Election of officers. Attendance: 20.

Feb. 23. Joint meeting with AIEE and IRE. Speaker: A. M. Pawson. Subject: Jet-Propulsion; Film. Attendance: 100.

Swarthmore College, Feb. 14. Business meeting. Attendance: 15.

University of Tennessee, Feb. 15. Speaker: C. B. Blackburn. Subject: Industrial Development in the South. Attendance: 22.

University of Texas, Feb. 6. Speaker: Eugene Pofahl. Subject: Steam-Turbine Electric Locomotive. Attendance: 80.

Feb. 20. Speaker: C. E. Davies, secretary ASME. Subject: Functions of the ASME. Attendance: 50.

Feb. 27. Speaker: L. E. Eaton. Subject: Heating Water With Combustion Gases. Attendance: 54.

Texas Technological College, Feb. 20. Speaker: R. G. West. Subject: The Preparation of Oxygen and Acetylene. Attendance: 45.

Tufts College, Feb. 21. Speaker: J. Goldsbury. Subject: Gas Turbines. Attendance: 42.

University of Utah, Feb. 14. Speaker: O. de Lorenzi. Subject: Burners for Liquid and Gaseous Fuels. Attendance: 41.

University of Vermont, Feb. 9. Business meeting. Attendance: 31.

University of Virginia, Feb. 24. Speaker: C. J. Owens. Subject: The Institute of Textile Technology. Attendance: 32.

Virginia Polytechnic Institute, Feb. 14. Film: The Unfinished Rainbow. Attendance: 60.

Feb. 21. Speaker: D. B. Dunlevey. Subject: What the Potential Engineer Should Be Thinking of Besides His Studies While in College. Attendance: 200.

State College of Washington, Feb. 9. General business meeting. Attendance: 19.

Washington University, Feb. 7. Business meeting. Attendance: 44.

Wayne University, Feb. 8. Speaker: Earl Riopelle. Subject: Wayne Mechanical-Engineering Alumni Association. Attendance: 66.

University of Wisconsin, Feb. 22. Speaker: J. F. Roberts. Subject: TVA Power Development. Attendance: 75.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after April 25, 1950, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

AKERS, DONALD HAYNES, Lanakai, Oahu, T. H.
ALIOTTI, REMO L., Hoboken, N. J.
ARCHER, D. K., Westchester, Ill.
BAHR, HARRISON C., Schenectady, N. Y.
BAILEY, JAMES R., Wilmington, Del.
BENHAM, WEBSTER LANCE, Oklahoma City, Okla. (Rt)
BIERWIRTH, CHARLES EUGENE, Flint, Mich.
BOTSOLAS, PHILIP, Plainfield, N. J.
BOWES, VINCENT EDWARD, Flushing, N. Y.
BROWN CALEB CANDEE, 3RD, Springfield, Vt.
BROWN, SAMUEL P., Short Hills, N. J.
BRUCH, CHARLES D., Scranton, Pa.
CALHOUN, JOHN D., Dubach, La.
CARLSON, KARL WILLIAM, Schenectady, N. Y.
CASSADY, JOHN L., Durham, N. C.
CHIDESTER, WILLIAM F. T., Philadelphia, Pa.
CIPRIANO, PETER A., Orange, N. J.
CLARKE, EUGENE G., Savannah, Ga.
CLARO, FRANCIS ROBERT, Bellerose, N. Y.
CORNEAU, FRANCIS G., Schenectady, N. Y.
COVERT, ELMER C., JR., Philadelphia, Pa.
CROSSFIELD, PHILIP J., Washington, D. C.
CURTIS, WALLIS S., E. Orange, N. J.
DAY, HARRY F., Winston-Salem, N. C.
DEITRICK, STAPLETON C., Nutley, N. J.
DICKINSON, N. L., JR., Alliance, Ohio
DOUGHERTY, C. R. G., New Brunswick, N. J.
DOWNING, JOHN CHARLES, Kenmore, N. Y. (Rt)
DOWNS, WILLIAM R., Houston, Texas
DOYLE, FRANK P., Staten Island, N. Y.
DUNCAN, J. RAY, Charleston, W. Va. (Rt)
EAST, LEO HERBERT, Rochester, N. Y. (Rt)
EVANS, JAMES ARTHUR, Massillon, Ohio
EVANS, STEVE WILLIAM, Schenectady, N. Y.
FLOWERS, JARROTT, Halloman, A. F. B., N. Mex.
FOX, DONALD L., American Fork, Utah
GAMBLE, GEORGE P., St. Louis, Mo.
GASSETT, STEPHEN A., Flushing, N. Y.
GERBER, THEODORE C., Washington, D. C.
GODDARD, KENNETH R., Savannah, Ga.
GROSE, WILLIAM EARL, Bridgeville, Pa.
GUHA, S. N., Patna, India
HART, JAMES E., Greensboro, N. C.
HATHAWAY, CHARLES A., Torrington, Conn.
HEATH, ROBERT EDGAR, Jersey City, N. J.
HIRSCHMANN, JULIO G., Valparaiso, Chile
HOLMES, ROGER L., JR., Atlanta, Ga.
HUDDLESTON, CHARLES E., E. Greenwich, R. I.
JAMESON, W. F., Kearny, N. J.
JAMISON, KENNETH E., Oak Ridge, Tenn.
JENKINS, THERON W., JR., Philadelphia, Pa.
JOHNSON, DAVID WILLIAM, Stanford, Calif.
KOHL, ERHARD O., Massillon, Ohio
KROS, GEORGE W., JR., Alliance, Ohio
LAL, SUKH SAMPAT, Bandra, Bombay, India

LANGFORD, JAMES M., Clarksville, Tenn.
LAPLANTE, ROBERT JOHN, Schenectady, N. Y.
LEHEBACH, CHARLES W., Boston, Mass.
LEISINGER, LEWIS M., New York, N. Y.
LINDGREN, JOHN R., Jacksonville, Fla.
MARSHALL, EARL P., Pasadena, Calif.
MARTIN, LUKE J., Milwaukee, Wis.
MASTER, GERALD LOUIS, Reading, Pa.
McMAHON, THOMAS J., Troy, N. Y.
MIKHALAPOV, G. S., Far Hills, N. J.
MILES, WILLIAM H., Bremerton, Wash.
MILLER, WILLIAM J., Schenectady, N. Y.
MINAULT, S. S., Binghamton, N. Y.
MOORE, CHARLES S., Cleveland, Ohio (Rt&T)
MORRIS, G. A., Cincinnati, Ohio
MUSAT, OLIVER D., Canton, Ohio
NICKELSJORN, HAROLD, Jersey City, N. J.
NOBLE, WILLIAM C., Levittown, N. Y.
NOVAK, EMIL J., Perth Amboy, N. J.
OCKER, EDWARD H., Park Hall, Md.
O'HARA, E. DANIEL, Fullerton, Calif.
OLCHOFF, MAURICE, Des Moines, Iowa
PAIGE, STUART, Bridgeport, Conn.
PATTEN, WALTER, W., Jr., Summit, N. J.
PETRENCO, ANATOLY V., Ann Arbor, Mich.
RAO, K. SITHARAMA, Madras, S. India
RASMUSSEN, A. C., Omaha, Nebr.
RAWSON, WILLIAM GEORGE, Moline, Ill.
REID, ANDREW, Methuen, Mass.
ROLLINS, ROBERT ELDRIDGE, Worcester, Mass.
RUSSELL, LAURIE R., Mission, Kans.
SCHAEFER, HENRY, Tulsa, Okla. (Rt & T)
SCHERRER, RICHARD E., Cleveland, Ohio
SCHNACKE, ARTHUR W., Schenectady, N. Y.
SEMANCIK, MICHAEL, Rittman, Ohio
SEMAR, HAROLD WALLS, Drexel Hill, Pa.
SETHURAMAN, A. V., Vepery, Madras, S. India
SHERMAN, ARTHUR F., Lawrence, Mass.
SIDOW, ORVILLE J., Olympia, Wash.
SILVER, BERNARD, New York, N. Y.
SLOANE, HERBERT H., Denver, Colo.
STEWART, ALBERT D., Jr., Philadelphia, Pa (Rt)
STOECKER, WILBERT F., Dunkirk, N. Y.
STONE, EUGENE F., Houston, Texas
STONE, WALKER G., Darien, Conn.
STORM, EDWIN L., Pittsburgh, Pa.
TANGERMAN, ELMER JOHN, Port Washington, N. Y. (Rt & T)
THOMAS, EVERETT E., Schenectady, N. Y.
TISSOL, A. E., Bartlesville, Okla.
TUCKER, HAL-B, Draper, N. C.
VOLTZ, PHILIP A., Philadelphia, Pa.
WERTHEIMER, MILTON A., Rock Island, Ill.
WHITTEN, DAVID R., Glenside, Pa.
WIGHTMAN, IRVING L., Denver, Colo.
WILLIAMS, J. DAVID, Portsmouth, Ohio
WILLIAMS, WILLIAM H., New Orleans, La.
WOITOVICH, JOHN M., Jamaica, N. Y.
WOLFORD, JAMES K., Baltimore, Md.
WOLIS, KARL ELLIS, Cleveland, Ohio
WOOLDRIDGE, JAY H., Jr., Kansas City, Kans.
YOUNG, EVERT A., Jacksonville, Fla.
YU, AI-TING, New York, N. Y.
ZOLTANI, CHARLES L., Alliance, Ohio

CHANGE IN GRADING

Transfers to Member and Associate

AGAR, J. W., Havre de Grace, Md.
ARCHBOLD, FRED GEORGE, Jr., Vallejo, Calif.
BOCK, ARTHUR E., Annapolis, Md.
BOYD, J. W., Kansas City, Mo.
CAMPANA, JAMES A., Jeannette, Pa.
DAWSON, H. W. A., Saskatoon, Sask., Canada
FORD, NORMAN M., Brooklyn, N. Y.
GATCOMBE, ERNEST K., Ferry Farms, Annapolis, Md.
GAYMAN, W. MERLIN, Pasadena, Calif.
GUNKEL, KENNETH MARVIN, Lima, Peru
HALBMILLION, VICTOR, Washington, D. C.
JAHNCKE, DONALD EDWARD, Grosse Pointe Woods, Mich.
JENSEN, ROBERT M., New York, N. Y.
LANG, HERMAN A., Chicago, Ill.
LETOURNEAU, SAMUEL D., Los Alamos, N. Mex.
LOVISEK, LOUIS J., Bellerose, N. Y.
MOORE, STANLEY M., Kokomo, Ind.
MUSCHETT, WILBERY R., W. Englewood, N. J.
OLSEN, LEROY S., W. Orange, N. J.
O'TOOLE, CHARLES B., Pittsburgh, Pa.
PUGH, DANIEL CLARK, S. Charleston, W. Va.
RANDICH, ERASMUS A., Pittsburgh, Pa.
SANDOR, GEORGE N., Springdale, Conn.
SCHABTACH, CARL, Schenectady, N. Y.
SHANK, J. M., Milwaukee, Wis.
SMITH, PAUL E., Columbus, Ohio
THOMAS, ROBERT LEWIS, Minneapolis, Minn.
THOMPSON, WILBERT, Detroit, Mich.
WILLIS, CULLIE BOGACKI, Montgomery, Ala.
WISE, MAX R., Tulsa, Okla.
YOUNG, JAMES F., Erie, Pa.

Transfer from Student Member to Junior 300

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York 8 West 40th St. | **Chicago** 84 East Randolph Street | **Detroit** 100 Farnsworth Ave. | **San Francisco** 57 Post Street

MEN AVAILABLE[1]

ENGINEER, 38, registered, fourteen years' experience, machine, tool, process design. Head plastics development, testing, application, design. Plant engineer, water treatment, steam, and power generation. Executive-level position desired. Philadelphia preferred. Me-660.

MECHANICAL ENGINEER, 24, married, BSME, 1949; MS, June 1950. Available for work in steam-turbine or power-plant design. One year experience drafting room, elevator design and layout. Location open. Me-661.

MECHANICAL-INDUSTRIAL GRADUATE, presently employed. Three years' experience in piping design and layout, desires change to become associated with company to build future, where possibility exists of eventually being advanced to the industrial-engineering phase of operations. New York, Massachusetts, or East, but not essential. Me-662.

INDUSTRIAL ENGINEER, 31, BSME, University of Iowa. Six and a half years' experience with both a large and a small company in all phases of methods, analysis, time study, wage incentives, etc. Desires position offering responsibility and future. Midwest or South preferred. Me-633-211 Chicago.

MECHANICAL ENGINEER, 27, BSME, married. Experience includes electronic instrument test, 1 year; heating and ventilating design, 1 year; mechanical-engineering test laboratory instructor, 3 years' evenings, also aircraft and engine-maintenance instructor during war. Location unimportant. Me-664.

SALES ENGINEER, five years' experience electromechanical equipment. Also experienced in negotiation of government research and development contracts. Location, New York, N. Y., but willing to travel. Me-665.

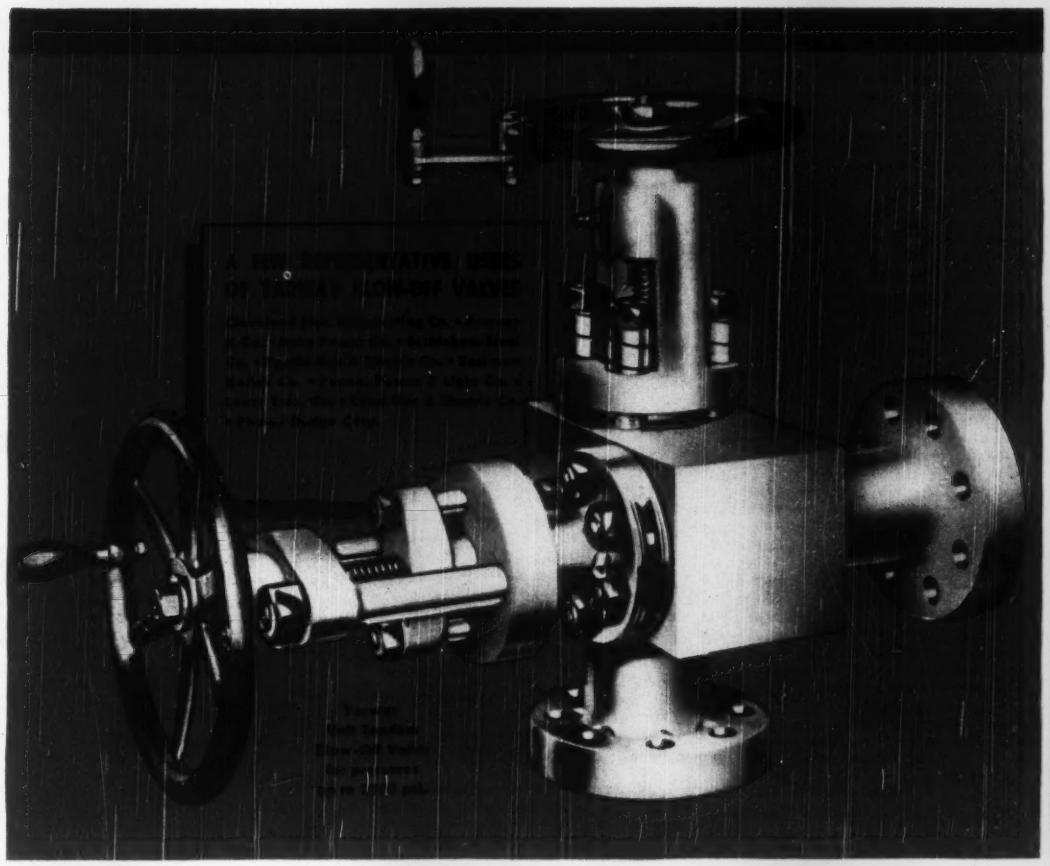
SALES ENGINEER, 35, ten years' experience in manufacturing methods, including metallurgy, quality control, foundry practice, refrigeration, plant layout, time and motion study, purchasing, sales, materials handling, and office management. Desires sales position preferably based in metropolitan N. Y. or N. J. Will travel. Available on notice. Me-666.

PRODUCTION MANAGER AND PLANT SUPERINTENDENT now ready to move up. Excellent background in metalworking production, business administration, costs, budgets, and personnel. Available as general manager or assistant general manager. Me-667-210 Chicago.

ASSISTANT PROFESSOR, mechanical engineering, 32, married. Ten years' combined teaching and industrial experience. Completing MS degree work, available September, 1950. Prefer West but will consider other locations. Me-668-502-D-5.

(*ASME News continued on page 364*)

[1] All men listed hold some form of ASME membership.



TIGHT! STRONG! for even toughest blow-down requirements

The Yarway Unit Tandem Blow-Off Valve meets the most demanding requirements for boiler blow-down or drain service.

It's drop-tight—and rugged enough to withstand the severe punishment of regular or emergency blow-down under pressure, or periodic acid wash.

Two Yarway Stellite-Seat Hard-Seat Valves or a Hard-Seat (blowing) and Seatless (sealing) Valve are combined in a one-piece forged-steel body. Designed for pressures up to 2500 psi.

It is significant that more than 4 out of 5 high pressure boiler plants use Yarway Blow-Off Valves.

For more facts, see Yarway Bulletin B-432.

YARNALL-WARING COMPANY
108 Mermaid Avenue, Philadelphia 18, Pa.
Branch Offices in Principal Cities

YARWAY **BLOW-OFF VALVES**

MECHANICAL ENGINEER, BSME, Kansas State, 1949, 21, married, one child. Good knowledge of Diesel engines and accessories. Desires position with large user or manufacturer of Diesel engines. Will locate anywhere or travel. Me-669.

MECHANICAL ENGINEER, ME, Stevens, February, 1950, 23, married, desires production or industrial engineering, or position leading to management. Metropolitan area or East. Me-670.

MECHANICAL ENGINEER, 27, fifteen months pattern shop, foundry, welding, machine-shop practice; nine months tool engineering, ten months quality-control engineer. Desires position in production or management fields. Me-671-255 Chicago.

SALES ENGINEER, trainee, 25, single, B. Mgt. Eng. RPI, January, 1950, in ME. Enthusiastic, aggressive, experience in sales, steel fabrication, and construction. Desires training position in technical sales. Me-672.

RECENT GRADUATE, BSME, 31, single. Apprentice and journeyman machinist on precision work. Desires trainee or junior engineer position in production, development, design, or methods in any industry. East or Midwest. Me-673.

ENGINEER, BSEE, M.I.T, 1945, age 26, married, Professional License, modern business course. Four years' manufacturing experience including design and production engineering. Desires employment requiring electrical and mechanical background. Prefers Southwest or Midwest. Me-674.

MECHANICAL ENGINEER, 31, three years of steam-turbine and hydraulic-control design; and five years of jet-engine testing, instrumentation, and laboratory operation. Will travel or relocate. Me-675.

MECHANICAL ENGINEER, 28, BME, RPI, married. Two and a half years' experience in metals testing and research. Interested in air conditioning, paper, or textile industries in the Northeast. Me-676.

RESEARCH DIRECTOR, 43, Sc.D. in metallurgy, broad background in brass-mill business for last thirteen years. Successful management experience with 1400 employees in production, but prefers administration or research. Present employer cannot offer suitable position, so will release on friendly basis with reasonable notice. Me-677.

MECHANICAL GRADUATE, 26, desires position in sales engineering. Three years' experience in job and project-engineering management involving refinery tankage, mechanical equipment. Engineering officer USNR. Married, two children. Will relocate. Me-678.

ENGINEER, PE., wide experience in design, operation, and maintenance of industrial power plants, both mechanical and electrical. Heat balances, coal and ash handling, power and light distribution. Operator's license. Me-679.

MECHANICAL ENGINEER, BME, honor fraternity, 28, married, veteran, seven years' tool, diemaking, die-sinking experience. Acquainted with setup, industrial processes, some design. Desires position, research or production anywhere. Available June. Me-680.

RECENT GRADUATE, 23, single, BSME, University of Connecticut. Desires trainee or junior position in design, development, or experimental testing. Prefers Northeast or South, but will relocate anywhere in the United States. Me-681.

MECHANICAL ENGINEER, 27, BME, RPI, single, recent graduate desires position in production or development. Two years' service experience on Diesel engines. Location East, preferably New England States. Me-682.

POSITIONS AVAILABLE

PLANT-LUBRICATION ENGINEER, 30-45, mechanical graduate, with at least five years' experience covering cutting oils, machinery lubrication, filtering equipment, etc., to select proper lubricants, specify quantities, methods of application, investigate bearing failures, and set up general maintenance-lubrication procedures covering machine-shop operations, internal-combustion engines, etc. $4800-$6000. New Jersey. Y-3255.

ENGINEERS. (*a*) Production manager, particularly experienced in inventory control, time study and methods for metal-process manufacturing. (*b*) Chief engineer, with ten to fifteen years' experience in internal-combustion-engine design. $12,000-$16,000. Maryland. Y-3282.

CHIEF MECHANICAL ENGINEER, to take charge of an architect-engineer's office of 60 to 75 men in connection with heating, piping, ventilating, and air conditioning of industrial and commercial buildings. $15,000. Michigan. Y-3296.

DESIGNER, mechanical graduate, 35-40, with five to ten years' experience on automatic-machine design. Experience in dry-battery manufacture desirable. $6000-$6500. Connecticut. Y-3301.

DESIGNER with recent experience in the design of heavy mechanical presses. Should be capable of doing independent design work on such machines and to some extent will also do some detailing as organization is small. Any experience in the design of heavy forge-shop machinery or hydraulic presses valuable, but primary requirement is for ability in the design of heavy crank-type forging presses. Pennsylvania. Y-3310-R-6267-D.

SAFETY ENGINEER, 26-28, engineering graduate, with industrial safety experience, to set up maintenance and operating safeguards covering steam and electric power and processing facilities, building maintenance and general manufacturing. $4000-$5000. Brooklyn, N. Y. Y-3321.

INDUSTRIAL ENGINEER with at least five years' manufacturing experience in printing paper, textile, or allied materials, to make production studies, plan improvements and assist management in operation of textile-printing plant. $5000-$6000. New Jersey. Y-3332.

JUNIOR ENGINEER, mechanical graduate, with experience in layout and detail of automatic printing and packaging equipment, to do drafting, testing, and report writing on special machinery and electromechanical devices. $3120-$3640. New York, N. Y. Y-3333.

MECHANICAL ENGINEER for refrigeration-compressor design, preferably with five to ten years' experience in design and development, open and sealed machines and systems for air conditioning and refrigeration, with well established company. New Jersey. Y-3342.

ENGINEERS. (*a*) Chief engineering draftsman, 35-50, to supervise about 25 draftsmen, gage designers, jig and fixture designers, die designers and small tool and cutter designers. Must be able to develop and assign engineering and tooling problems as they are given to him by the engineers so that draftsmen can complete them. Production experience desirable. $5200. (*b*) Statistical quality-control engineer experienced in theory of statistical quality control and its practical application to industrial problems. Will be responsible for the analysis of operations which are considered "out of control" and for recommending corrective action as determined by statistical data. General knowledge of principal mechanical processes necessary. $4800. Connecticut. Y-3343.

ENGINEERS. (*a*) Design and development engineer, 35-40, mechanical graduate, with design, development, product engineering, and general machine-shop experience, for staff position with manufacturer of household products and industrial equipment. Small tank and miscellaneous metal fabrication also desirable. $5000-$6000. New York, N. Y. (*b*) Design and development engineer, under 35, with industrial-instrument experience, to design instruments for flow measurements and control of liquids and gases. $4000-$5000. Eastern Pennsylvania. Y-3346.

ASSISTANT TO CHIEF ENGINEER, 35-45, with degree in electrical or mechanical engineering, and with a minimum of five years' experience in manufacture and design of light electromechanical acoustical devices. $5000-$5500. New York, N. Y. Y-3347.

PACKAGING ENGINEER with four to five years' experience in all packaging materials. Knowledge of paperboard and films essential. Background in food-container industry preferred. Project engineer experience helpful. About $4800. Illinois. R-6220.

CHIEF ENGINEER to supervise engineering design, production, and sales for a manufacturer of excavating machinery. Good personality and broad experience in heavy industries. Salary open. Illinois. R-6249.

Obituaries

Charles Irvine Burkholder (1872–1948)

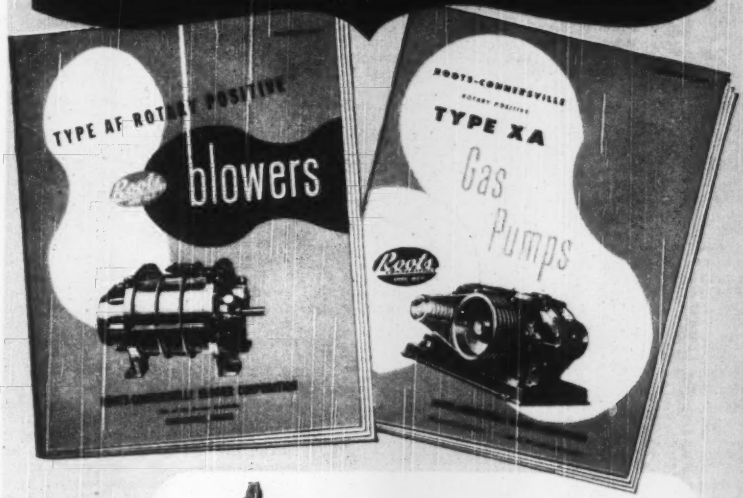
CHARLES IRVINE BURKHOLDER, vice-president, chief engineer, Duke Power Co., Charlotte, N. C., died in Charlotte, March 13, 1948. Born, Sterling, Ill., Oct. 9, 1872. Parents, Christian and Mary (Irvine) Burkholder. Education, BSEE, University of Wisconsin, 1896. Married Clara M. Sauter, 1908. Honorary DE, North Carolina State College of Agriculture and Engineering of the University of North Carolina, 1938. Mem. ASME, 1912. Survived by wife.

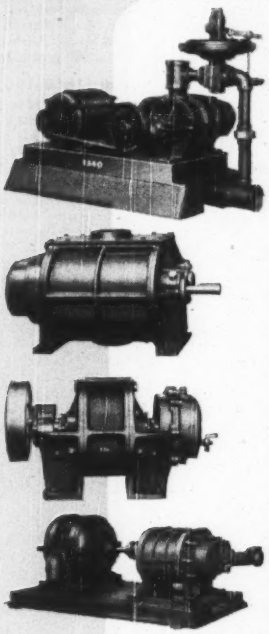
William Edward Brennan (1896–1949)

WILLIAM E. BRENNAN, engineer, Customers Service Division, Detroit (Mich.) Edison Co., died in Detroit, Nov. 18, 1949. Born, Detroit, June 15, 1896. Parents, James J. and Bessie A. Brennan. Education, BSME, University of Michigan, 1922. Jun. ASME, 1923; Assoc. Mem. ASME, 1926; Mem. ASME, 1935. Survived by wife, whom he married in 1924; his

(*ASME News continued on page 366*)

Ready Now!





TWO NEW R-C BULLETINS

for smaller volume, moderate pressure applications of gas and air

If you are handling gas or air for any of the purposes listed at the right, or for similar applications, you need these two new, descriptive bulletins on the smaller sizes of Roots-Connersville Blowers and Gas Pumps.

These booklets bring you up to date on construction, capacities, regulation, control and other details on R-C Type AF Blowers (Bulletin 21-B-37) and Type XA Gas Pumps (Bulletin 31-B-17). Send for them or write us about your needs, for engineering analysis, without obligation.

ROOTS-CONNERSVILLE
BLOWER CORPORATION
504 Michigan Avenue,
Connersville, Indiana

1. Air for combustion with oil or gas burners, small cupolas, coke-fired forges, etc., in:

Iron and steel works
Food processing industries
Neon sign shops
Chemical processes
Nonferrous foundries
Asphalt heaters
Smelters
Oil-fired forges
Bakeries
Ceramic, brick and tile mills

2. Aerating and agitating liquids, in:

Ice plants
Sewage and industrial waste disposal
Electroplating, engraving and electrotyping
Fish tanks or trucks, also shallow lakes
Oyster washing
Water treatment
Protecting dams from ice
Fruit, vegetable and poultry washing and cooling
Blending vinegar, fruit juices, etc.
Compounding oils

3. Miscellaneous pressure or suction uses:

Pneumatic conveying of grains, insulation and liquids
Rock dusting in mines
Dust collecting systems
Low pressure sandblast
Respirators and safety helmets
Testing rubber balloons, etc.
Cleaning forging dies, motors and machines
Boosting inlet pressure of compressors
Drying barrels and drums
Blowing cake off filters
Air seal for bearings of rock crushers, etc.
Pneumatically controlled valves
Steam garment presses
Printing presses
Paper folding machines
Vacuum chucks
Drying yarns, textiles, etc.

4. Gas Pumps for:

Boosting fuel supply to industrial furnaces
Chemical processes and refineries
Boosting pressure from small gas wells
Neon sign shops
Gas sampling equipment
Inert gas generators
Exhausting oil vapors
CO_2 collectors
Boosting supply to gas engines

ROOTS-CONNERSVILLE
BLOWER BUILDERS SINCE 1854
ONE OF THE DRESSER INDUSTRIES

DOING ONE THING WELL FOR ALMOST A CENTURY

father, of Lakeland, Mich.; and a brother, J. F. Brennan, San Francisco, Calif.

Elbert Henry Carroll (1867–1947)

ELBERT H. CARROLL, whose death on Nov. 15, 1947, was recently reported to the Society, was president and treasurer of the Carroll Pressed Metal Co., Inc., Worcester, Mass. Born, Medway, Mass., April 7, 1867. Parents, William T. and Frances C. (Taft) Carroll. Educated at Worcester Polytechnic Institute. Married Elizabeth C. Moore, 1893. Mem. ASME, 1900. Survived by wife.

Addison L. Clark (1871–1949)

ADDISON L. CLARK, retired 1943 as president, Pacific Coast Division, American Brake Shoe Co., died Nov. 28, 1949, in Los Altos, Calif. Born, New York, N. Y., June 13, 1871. Parents, Mr. and Mrs. Eadon P. Clark. Education, public schools. Married Lillian Russell. Mem. ASME, 1915. Survived by wife and two sons, Russell Everett, Mountain View, Calif., and Addison Gillette, San Francisco, Calif.

Garrett Putnam Serviss Cross (1880–1949)

GARRETT P. S. CROSS, mechanical engineer, Research Division, United Shoe Machinery Corp., Beverly, Mass., died in Beverly, April 15, 1949. Born, Fultonville, N. Y., Sept. 20, 1880. Parents, Jerome A. and Anna (Serviss) Cross. Education, ME, Syracuse University, 1906. Married Nellie E. Billington, 1908, son, Allan B. Mem. ASME, 1913. Survived by wife and son.

Newton Ross Elliott (1874–1949)

NEWTON ROSS ELLIOTT, engineer, draftsman, City of South Portland, Maine, died Dec. 26, 1949. Born, Lakeville, Nova Scotia, Can., May 27, 1874. Parents, John B. and Estella A. (Smith) Elliott. Education, Cape Elizabeth High School; ICS. Naturalized, Portland, Maine, Sept. 8, 1896. Married Ada W. Cribby, 1907. Assoc. Mem. ASME, 1917, Mem. ASME, 1935. Survived by wife.

Henry Hammett Fales (1881–1949)

HENRY H. FALES, consulting engineer, Providence, R. I., died June 3, 1949. Born, Norfolk, Mass., Oct. 30, 1881. Education, BS, M.I.T., 1903. Mem. ASME, 1913.

Leslie Norman Leet (1896–1949)

LESLIE N. LEET, founder and for 17 years president of the Leet Organ Co., Inc., of Cranford, N. J., and author of a textbook, "Introduction to the Organ," died in Muhlenberg Hospital, Plainfield, N. J., Dec. 11, 1949. Born, Boston, Mass., June 12, 1896. Education, Boston Latin School. Mem. ASME, 1943–1947. The members of the Society will best remember Mr. Leet as the organist who played the national anthem and other appropriate music for their entertainment at the annual banquet. He was a founder of the Acoustical Society of America. Survived by wife, Mary Peirce Leet; a son, Edwin; a daughter, Mrs. John J. Lowry; his mother, Mrs. Maude Leet, a brother, George Leet, and a grandchild.

Sherman Nussey Miller (1878–1949)

SHERMAN N. MILLER, vice-president in charge of engineering, American Locomotive Co., Schenectady, N. Y., died at his home in Schenectady after a long illness on Sept. 24, 1949. Born, Cassadaga, N. Y., June 19, 1878. Education, ME courses, Purdue University, 1902–1904. Married Cora Bullock. Mem. ASME, 1944. Survived by wife and a daughter, Mrs. Helen Snipes, Rochester, N. Y.

French Hugh Morehead (1883–1949)

F. HUGH MOREHEAD, vice-president in charge of engineering, Walworth Co., Inc., Los Angeles, Calif., died Nov. 27, 1949. Born, Paris, Mo., Nov. 23, 1883. Parents, John Quarles and Mary (Glascock) Morehead. Educated, BSME, University of Missouri, 1904. Married Clo Searcy, 1907 (deceased 1914); son, T. Searcy (dec.). Married 2nd, Frances Thronton, 1925. Assoc. Mem. ASME, 1919; Mem. ASME, 1935. Author of many papers on valves, piping, etc.

George McClellan Nelson (1898–1949)

GEORGE MCCLELLAN NELSON, assistant to chief engineer, Union Oil Co. of California, Los Angeles, Calif., died in Antwerp, Belgium, Oct. 23, 1949. Born, Sedalia, Mo., Jan. 30, 1898. Parents, George McClellan and Caroline L. Nelson. Education, BSME, Washington University, 1919. Married Ella Elizabeth De Vare, 1922; a son. Mem. ASME, 1947. Survived by wife.

Frederic Alan Schaff (1884–1950)

FREDERIC ALAN SCHAFF, chairman of the board of directors of Combustion Engineering-Superheater, Inc., died at his home in Bronxville, N. Y., Feb. 7, 1950, after a long illness. Born, Nelsonville, Ohio, May 24, 1884. Parents, Charles Ellsworth and Leila Belle (White) Schaff. Education, Culver Military Academy; BS, Purdue University, 1907. Honorary degree DE, Purdue University, 1949. Married Mary Lee Brittain, 1911; children, Jane Lee, Mary Alan. Assoc. Mem. ASME, 1915; Mem. ASME, 1926; Fellow ASME, 1945. Served the Society as finance committee chairman, 1929-1930. Mr. Schaff, widely known in both railroad and power fields, was an officer or a director of many companies making equipment for both fields. He was chairman and director of The Lummus Co. and The Air Preheater Corp., president and a director of The Superheater Co, American Throttle Co., and the Combustion Publishing Co., and a director of the Lima-Hamilton Corp. and the Franklin Railway Supply Co. He also held important posts with foreign affiliates of several of these companies. Survived by his wife and two daughters, Mrs. Albert B. Boardman, 2nd, Rye N. Y., and Mrs. E. Austin Byrne, Mamaroneck, N. Y.; and five grandchildren.

Arthur S. Vincent (1868–1949)

ARTHUR S. VINCENT, who retired in 1936 as chief engineer, Federal Reserve Bank Building, New York, N. Y., died in his home at Mountain Lakes, N. J., Dec. 9, 1949. Born, Westerly, R. I., Jan. 4, 1868. Parents, Thomas and Clara L. Vincent. Education, public schools, Westerly, R. I.; Pratt Institute. Married Elsie Tibbits, 1896. Assoc. ASME, 1909, Mem. ASME, 1923. Survived by two daughters, Marion, Mountain Lakes, N. J., with whom he resided; and Mrs. L. L. Van Schoonhoven, Larchmont, N. Y.

Walter Edwin Winship (1872–1949)

WALTER E. WINSHIP, whose death was recently reported to the Society, was president, Winship Oils, Inc., New Orleans, La. Born, Providence, R. I., June 16, 1872. Education, AM, Stanford University, 1896; PhD, Berlin (Germany) University, 1899. Mem. ASME, 1908.

ASME Master-File Information

Please Print — **Check Mailing Address**

Name
Last First Middle

Home Address
Street City Zone State

Name of Employer — Division of Firm

Address of Employer
Street City Zone State

Product or Service of Company

Title of Position Held in Company

Nature of Work Done

I am a subscriber of (please check)

Transactions ☐ Journal of Applied Mechanics ☐ Applied Mechanics Review ☐

Notify Headquarters Promptly of Changes

Keep Your ASME Records Up to Date

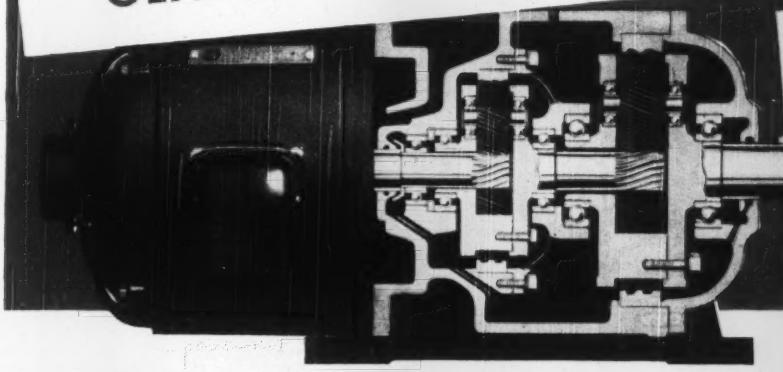
HEADQUARTERS depends on its master membership file for answers to hundreds of inquiries daily pertaining to its members. All other Society records and files are kept up to date through changes processed through it. The listings in future ASME Membership Lists will be taken directly from the master file. It is important to you that it lists your latest mailing address and your current business connection.

The mailing form on this page is published for your convenience. You are urged to use it in reporting recent changes.

Your mailing address is important to Headquarters. Please check whether you want your mail sent to home or office address.

for LARGE DRIVES too

GEAR-MOTORS—UP TO 150 hp.



THE GEAR SYSTEM IS A HONEY!

You get a compact, quiet planetary-gear system, designed for high efficiency and long life. Planetary gear reduction gives you smooth transmission with the greatest load-carrying capacity in the smallest space.

G-E TRI/CLAD gear motors... compact, efficient, extra-protected

At the Clark Hill Dam in Georgia, this 50-hp G-E gear-motor drives a belt conveyor off a secondary crusher. Tri-Clad integrated design provides necessary protection from weather.

Even for large low-speed drives up to 150 hp, there's a G-E gear-motor that can fill the bill. With it you eliminate separate gears or reducers, because you buy only one compact, pre-engineered power package. You save purchasing and engineering costs by specifying one unit to do the job.

In hazardous areas, too, G-E explosion-proof gear-motors offer extra protection for applications where open gears, belts, and pulleys are prohibited.

. . . and in addition to these features, you get:

UNIT RESPONSIBILITY—G.E. assumes unit responsibility for both gear and motor, whether it's rated at 1 or 150 hp. You avoid many design and purchasing problems.

PRE-ENGINEERING—G-E gear-motors are pre-engineered to work as a unit, give you the best possible combination of gear and motor for your job.

OVER-ALL PROTECTION—Integrated housing shields the whole unit from dust and dirt, permits application where chains and belts cannot be used.

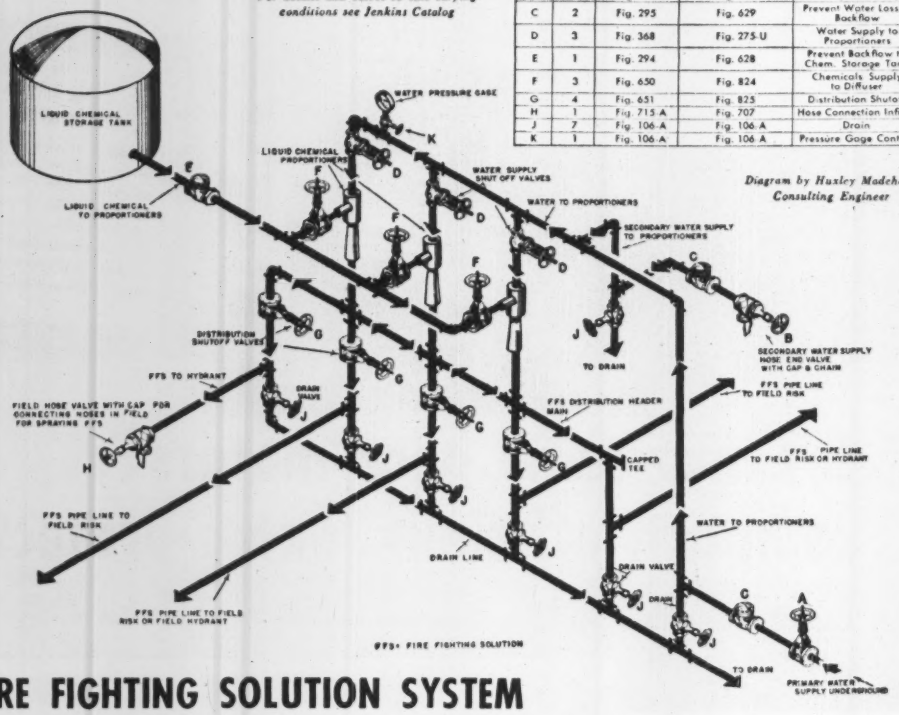
Standard ratings up to 75 hp are available from stock, and special quotations are issued for ratings up through 150 hp. To fill your needs on all gear-motor requirements, call your nearest G-E Sales Office or your local distributor. **Apparatus Dept., General Electric Co., Schenectady 5, N. Y.**

GENERAL ELECTRIC

JENKINS PRACTICAL PIPING LAYOUTS 49

Code	QUAN.	For Standard Industrial Installation	For Underwriters' Approved Installation	Service
A	1	Fig. 651	Fig. 825	Primary Water Supply Control
B	1	Fig. 715-A	Fig. 707	Auxiliary Water Supply
C	2	Fig. 295	Fig. 629	Prevent Water Loss or Backflow
D	3	Fig. 368	Fig. 275-U	Water Supply to Proportioners
E	1	Fig. 294	Fig. 628	Prevent Backflow to Chem. Storage Tank
F	3	Fig. 650	Fig. 824	Chemicals Supply to Diffuser
G	4	Fig. 651	Fig. 825	Distribution Shutoff
H	1	Fig. 715-A	Fig. 707	Hose Connection Infield
J	7	Fig. 106-A	Fig. 106-A	Drain
K	1	Fig. 106-A	Fig. 106-A	Pressure Gage Control

VALVE RECOMMENDATIONS
For details and valves to suit varying conditions see Jenkins Catalog


LIQUID CHEMICAL STORAGE TANK
WATER PRESSURE GAGE
LIQUID CHEMICAL PROPORTIONERS
WATER SUPPLY SHUT OFF VALVES
WATER TO PROPORTIONERS
SECONDARY WATER SUPPLY TO PROPORTIONERS
LIQUID CHEMICAL TO PROPORTIONERS
DISTRIBUTION SHUTOFF VALVES
FFS TO HYDRANT
FIELD HOSE VALVE WITH CAP FOR CONNECTING HOSES IN FIELD FOR SPRAYING FFS
DRAIN VALVE
TO DRAIN
SECONDARY WATER SUPPLY HOSE END VALVE WITH CAP & CHAIN
FFS PIPE LINE TO FIELD RISK
FFS DISTRIBUTION HEADER MAIN
CAPPED TEE
FFS PIPE LINE TO FIELD RISK OR HYDRANT
FFS PIPE LINE TO FIELD RISK
WATER TO PROPORTIONERS
DRAIN LINE
DRAIN VALVE
DRAIN
FFS PIPE LINE TO FIELD RISK OR FIELD HYDRANT
TO DRAIN
PRIMARY WATER SUPPLY UNDERGROUND

FFS- FIRE FIGHTING SOLUTION

Diagram by Huxley Madeheim Consulting Engineer

FIRE FIGHTING SOLUTION SYSTEM

The fire fighting system most frequently installed employs liquid chemical for the flame-smothering foam solution, as illustrated in the accompanying diagram.

When a fire occurs the primary water supply valve is opened, as are individual liquid chemical and water supply valves on the lines feeding the liquid chemical proportioners. As the water flows through the proportioners, it siphons chemical from the storage tank and mixes with it to form the foam.

Two sets of Jenkins Valves are recommended for the system shown here, one for standard industrial installations, the other for Underwriters' Approved Installations. The Fig. 715-A Bronze Fire Line Angle Valves used are approved by the Board of Standards and Appeals of the City of New York.

Consultation with accredited piping engineers and contractors is further recommended when planning any major piping installation.

A CHOICE OF OVER 500 VALVES

To save time, to simplify planning, to get all the advantages of Jenkins specialized valve engineering experience, select all the valves you need from the Jenkins Catalog. It's your best assurance of lowest cost in the long run, and *you pay no more* for Jenkins Valves despite their extra value. Jenkins Bros., 80 White St., New York 13; Jenkins Bros., Ltd., Montreal.

Reserve your copy of NEW BOOK OF PIPING LAYOUTS Nos. 26 to 50

A new book of Jenkins Practical Piping Layouts — Nos. 26 to 50 — including above, is in preparation. Mail coupon to get your copy when ready.

JENKINS BROS., 80 White St., N. Y. 13, N. Y.

Reserve copy of New Piping Layout Book for

Name _____

Company _____

Address _____

JENKINS
LOOK FOR THE DIAMOND MARK
VALVES
SINCE 1864
MADE TO JENKINS MARK

BUYER'S CATALOG GUIDE

LATEST INDUSTRIAL LITERATURE

Those in industry who are responsible for various phases of plant, machinery, and product design, production, operating and application engineering will find much to interest them in this Buyer's Catalog Guide. Here, reputable manufacturers whose current advertising appears in MECHANICAL ENGINEERING and ASME MECHANICAL CATALOG AND DIRECTORY offer to send you, without obligation, their latest literature which is described on pages 43 to 60. Make use of the coupon on page 42.

Catalog Index By Products

Air Conditioning Equipment 21, 127
Air Cooled Engines 126
Air and Gas Compressors 7
Air Heaters 153
Air Operated Cylinders 12, 124
Air Preheaters 56
Air Separators 16
Air Tools 33
Air Traps 83
Ammonia Compressor Valves 32
Ammonia Compressors 21
Ash Handling Equipment 89
Automatic Controls 8, 16, 19, 146
Axial Piston Motors 124

Ball Bearing Swivel Joints 39
Ball Bearings 9, 37, 72, 91, 120
Belt Drives 104
Benders 52, 141
Black and White Prints 82
Blast Cleaning 116
Blow-off Valves 46
Blowers 81, 140, 148
Books 107, 115
Boring Mills 152
Bronze Casting Alloys 109
Bushings 112

Car Shakers 50
Casting Alloys 109
Centralized Lubrication Systems 70
Centrifugal Blowers 140
Centrifugal Pumps 118, 125
Chain Drives 25
Chemical Scale Removal 137
Chlorinizers 94
Choppers 4
Clutches 80, 105
Coal Bunkers 89
Coal Conveyors 89
Coal Crushers 18
Coal Handling Equipment 89
Colored Pencils 13
Compressor Drives 104
Compressor Plates and Discs 32
Compressor Valves 32
Condensate Drainage Control 90
Condensers 21
Cone-Drive Gears 106
Cone-Drive Speed Reducers 106
Conveyor Chains 49
Conveyors 45
Cooling System Problems 137
Cooling Towers 21
Cooling Units 127
Copper Tubing 134
Copying Process 82
Corrosion Service Piping 160
Couplings 105
Crushers 4, 18, 29
Cutters 52
Cylinders 12, 124

Deep Drawn Shapes 161
Diaphragm Valves 150
Die-Less Duplicating Equipment 141
Dies 52
Direct Fired Air Heaters 153
Displacement Blowers 140
Displacement Meters 140
Dowel Pins 35
Dowtherm Vaporizers 132
Drafting Materials 10
Drafting Room Equipment 5
Drafting Room Furniture 5
Drawing Instruments 10
Drawing Materials 10
Drawing Pencils 13
Drawing Presses 161
Drawing Tables 5
Drop Forgings 138, 158
Dust Collectors 59, 128
Dust Control 116

Eductors 122
Electric Arc Welding 139
Electric Heating Units 159
Electric Motor Parts 63
Electric Motors 28
Evaporative Condensers 21
Exhaust Fans 148
Exhausters 140
Expansion Joints 46

Fan Drives 104
Fans 148
Felt 154
Filters 30
Fittings and Carriers for Wall Fixtures 100
Flat Lapping 27
Flexible Couplings 44, 66, 111
Flexible Pipe Joints 39, 79
Flexible Shafting 133
Float Valves 16, 41
Flooring 64
Flow Indicators 155
Flow Meters 155
Fluid Drives 124, 135
Fluid Motors 124
Fluid Power Equipment 124, 135
Fluid Pumps 124
Foam Rubber 143
Forged Steel Flanges 31, 97
Forgings 138, 158
Fork-lift Trucks 20, 149
Fractional Horsepower Gears 131
Freon Condensing Units 21
Furnace Walls 38

Gage Cocks 16
Gas Meters 24
Gas Pressure Regulators 24
Gas Pumps 140
Gaskets 55, 88
Gasoline Engines 126
Gasoline Meters 24
Geared-Head Lathes 145
Geared Turbine Units 34
Gearmotors 144
Gears 2, 58, 131
Grating-Flooring 64
Greases 76
Grinders 4

Heat Exchangers 21, 99
Heat Recovery Equipment 38
Heat Transfer Equipment 21, 99
Heating Boilers 53
Heating Elements 159
Heating Units 127, 159
Herringbone Gear Speed Reducers 2
High Vacuum Apparatus 51
Hydraulic Power Units 124, 135
Hydraulic Presses 93
Hydraulic Valves 102
Hydraulically Operated Cylinders 12, 124

Illuminators 16
Indicating, Recording and Controlling Instruments 19, 87
Industrial Trucks 20, 149
Inert Gas Generators 140
Instrument Valves 3
Instruments 19, 85, 87, 92, 157
Insulated Piping 156
Insulated Piping Systems 156
Iron Cements 95

Jaw Crushers 29

Lathes 145
Lever-Sealed Valves 84
Lift Trucks 20, 149
Link Grate Stokers 1, 62, 114
Liquid Control Equipment 16, 41
Liquid Level Indicators 46
Liquid Level Recorders 46
Liquid Meters 24
Lubrication 76
Lubrication Systems 70

Machinery Mountings 119
Materials Handling Equipment 20, 45, 149
Metal Working Tools 52, 145
Metallic Gaskets 55, 88
Metallic Packings 55, 88
Miniature Ball Bearings 72, 120
Motor Speed Control 40
Multiport Valves 14
Multitherm Units 127

Notchers 141

"O" Rings 17, 74
Oil Burners 36
Oil Meters 24
Oil Seals 117
Oscillographs 157
Overfeed Stokers 43
Overhead Piping Systems 156

Packaged-Type Boilers 132
Packaged-Type Compressors 7
Packings 17, 88
Photographic Papers for Engineering 151
Pillow Blocks 15
Pipe 31, 97
Pipe Fittings 31, 97, 160
Pipe Flanges 97, 160
Pipe Hangers 73
Pipe Revolving Joints 79
Pipe Swivel Joints 39, 79

Continued on Page 42

Use Coupon on Page 42

CATALOG ITEMS Start on Page 43 and Run to Page 60 Inclusive

BUYER'S CATALOG GUIDE . . . LATEST INDUSTRIAL LITERATURE

Pipeline Strainers 22
Piping 97, 160
Piping Systems 156
Plastic Mills 162
Plate Fabrication 68, 99
Plug Valves 24
Pneumatic Cylinders 12, 124
Pneumatic Tools 33
Pneumatic Transmitters 155
Portable Air Tools 33
Portable Power Tools 33
Positive Displacement Blowers 81
Positive Displacement Meters 140
Power Benders 141
Power Presses 23, 93, 161
Power Shears 141
Power Take-Offs 80
Power Tools 33
Power Transmission Equipment 25, 49
Power Units 124, 135
Prefabricated Piping 97
Pressure Gages 75
Pressure Regulators 16, 24
Pulverizers 4, 18
Pump Drives 104
Pumps 11, 26, 48, 51, 54, 118, 125, 129, 140
Punch Press Feeders 23
Punches 52, 141

Push-Pull Controls 67
Pyrometers 19

Reciprocating Pumps 48
Refrigeration Equipment 21
Regulators 8, 24
Relief Valves 16
Remote Push and Pull Controls 67
Reproduction Material for Engineering 151
Revolving Pipe Joints 39, 79
Rod Parters 141
Roller Bearing Pillow Blocks 15
Roller Bearings 47, 91
Roller Chains 25, 49
Rotary Positive Blowers 140
Rotary Swivel Joints 79
Roughness Measurement 103
Rubber Mills 162
Rubber Mountings 119

Safety Treads 64
Screw Thread Inserts 60
Sealed Ball Bearings 9
Seamless Steel Tubing 123
Seamless Welding Fittings 31, 97
Self-Lubricating Bushings 112
Shaft Seals 17, 147
Shears 141

CATALOG ITEMS
Start on next page

Short Center Drives 104
Shredders 4
Skids 149
Slip Clutches 105
Smoke Density Recorders 85
Solenoid Valves 86
Speed Measuring Instruments 113
Speed Reducers 2, 6, 77, 106, 121, 144
Sponge Rubber 143
Spray Nozzles 46
Spreader Stokers 43, 96, 114
Sprockets 25, 49
Stainless Steel Piping 160
Stainless Steel Pumps 118
Steam Boilers 38, 53, 57, 69, 98, 110, 132
Steam Cleaners 61
Steam Generators 38, 132
Steam Purifiers and Scrubbers 38
Steam Specialties 46
Steam Traps 16, 46, 71
Steam Turbines 34, 65, 78, 108
Steel Boilers 53, 57
Steel Flanges 31
Steel Plate Fabrication 68, 99
Steel Tubing 123, 134
Stokers 1, 43, 62, 96, 98, 114
Strain Analyzers 101, 142
Strain Gages 101, 142
Strain Measurement 101, 142
Strainers 16, 22, 30, 46
Suction Pumps 129
Surface Roughness Measurement 103
Supporting Wall Fixtures 100
Swivel Pipe Joints 39, 79

Tachometers 113
Technical Books 107, 115
Temperature Regulators 16, 19
Temperature Transmitters 92
Thermostats 136
Thin Colored Pencils 13
Threading Machines 23
Tower Packing 55
Tracing Files 5
Traveling Grate Stokers 96
Tubing 123, 134
Turbine Pumps 26
Turbine Type Pumps 125
Turning Mills 152

Underfeed Stokers 43, 62
Underground Piping Systems 156

Vacuum Gages 51
Vacuum Pumps 51, 54, 140
Valve Discs and Plates 32
Valves 3, 14, 16, 21, 24, 32, 41, 46, 84, 86, 102, 150
Vane Pumps 11, 54
Variable Speed Transmissions 124, 135
Ventilating Fans 148
Vibration Control 119
Vibration Control Mountings 119
Vibration Fatigue Testing Machines 42

Wall Fixture Fittings 100
Wall Fixture Supports 100
Waste Heat Units 132
Water Columns 46
Water Gages 16, 46
Water Jet Eductors 122
Water Meters 24
Water Purification 130, 137
Water Softeners 130
Water Systems 125
Water Traps 83
Water Treatment 137
Water Tube Boilers 38, 53, 69, 110, 132
Welding Equipment 139
Welding Fittings 31, 97, 160
Whiteprint Process 82
Worm Gear Speed Reducers 6, 77, 121

Mail This COUPON Today

MECHANICAL ENGINEERING
29 West 39th St., New York 18, N. Y.

Date .....

Please send me without cost or obligation the literature indicated by the following circled numbers which appear in "BUYER'S CATALOG GUIDE" in the April 1950 issue.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112
113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128
129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144
145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
161	162														

DISTRIBUTION BY US TO STUDENTS NOT INCLUDED

To receive literature requested—***Firm Connection and Occupation Must Be Given***

Name ..... PLEASE CHECK ☐ A.S.M.E. Member ☐ Non-Member

Position .....

Company .....

Address .....

4-50

NOT GOOD IF MAILED AFTER MAY 10, 1950

(Foreign Requests May be Mailed up to May 20, 1950)

CATALOG GUIDE

1 STOKERS

Westinghouse Electric Corp.—Booklet B-2196-A "Westinghouse Single-Retort Link-Grate Stokers" discusses the savings in steam costs possible through underfeed stoker firing, utilizing the unique Westinghouse Link-Grate principle of undulating grate motion. Application to boilers ranging in size from about 150 boiler horsepower upward, with capacities up to approximately 40,000 pounds of steam per hour, are illustrated with actual installation examples. Westinghouse consultation and field service facilities are explained in detail.

2 GEARS AND GEAR PRODUCTS

Western Gear Works—Aircraft Equipment Bulletin 4801 and Aircraft Actuator Bulletin 4811 show a wide variety of typical Pacific-Western aviation product designs and applications. Catalog 4403 on right angle speed reducers and 4802 on herringbone reducers provide complete information on design and application of all sizes, ratios and horsepower ratings.

3 NEW INSTRUMENT VALVES

Edward Valves, Inc.—New Edward Bulletin No. 491 providing information on the new drop forged steel Edward Instrument valves for meter, gage, instrument, and other small lines. These new valves have a rating of 6000 lb WOG at 100°F or 1500 lb sp at 1000°F. Bulletin 491 contains dimensions, weights, prices, and operating data.

4 CRUSHERS

American Pulverizer Co.—Bulletin illustrates and describes in detail complete line of custom-built Crushers, Grinders, Shredders and Choppers for uniform reduction. Includes cut away and cross sectional views as well as engineering data and specifications.

5 DRAFTING ROOM EQUIPMENT

Hamilton Mfg. Co.—Drafting equipment described in Hamilton Catalog No. 13 S . . . Auto-Shift tables with instant adjustment for height and slant from horizontal to vertical . . . tracing files with patented tracing lifter, making every sheet a top sheet . . . and a complete line of files and drawing tables to meet all requirements.

6 WORM GEAR SPEED REDUCERS

Cleveland Worm & Gear Co.—Bulletin "More Horsepower Per Dollar"—presenting a series of photographs and cost information on Speedaire Worm Gear Speed Reducers in different industries. Speedaire is a fan-cooled unit which will deliver up to double the horsepower of standard worm units of equal frame size at usual motor speeds.

7 NEW PACKAGED-TYPE HEAVY-DUTY COMPRESSORS

Ingersoll-Rand Co.—Folder describing entirely new packaged-type L-design, two-stage, 100-psi air compressor with built-in synchronous motor. Sizes 125 to 350 hp for continuous full-load service. Incorporates a "new look" and new ideas, such as "Pipeless, Thru-Frame Air Flow" from intake to discharge connections which are on the frame; packaged, tube-and-finned intercooler within the same frame; and full-floating aluminum bearings. Engineered for simplicity, compactness, high efficiency, lower installation cost, and minimum of adjustments and maintenance.

8 AUTOMATIC REGULATORS

Powers Regulator Co.—Bulletin 329 gives information regarding No. 11 self-operated regulator, used on water and oil heaters, crude oil treaters, tanks, vats, kettles, dryers, etc. Bulletin gives valuable tables for selecting proper size regulator, adequately illustrates broad scope of automatic control, and gives pertinent applications of No. 11 regulator.

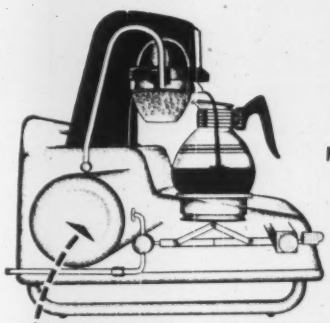
9 FAN AND WATER PUMP BALL BEARINGS

Marlin-Rockwell Corp.—Newly issued Booklet contains sketches of 14 different designs of M-R-C Fan and Water Pump Bearings. A bearing of this type may be found to be suitable for other applications where it is inconvenient or undesirable to use two single-row bearings; examples of these are saw arbors, drill presses, belt idlers, textile spindles, jet pumps, etc. The bearing is sealed at both ends, permitting a supply of initial lubricant which will last the entire life of the bearing.

10 DRAWING AND ENGINEERING INSTRUMENTS

Theo. Alteneder & Sons—1950 Catalog covering Precision Drawing Instruments, Drafting Scales, Stainless Steel T-Squares, Triangles and Straight edges. Manufacturers of fine tools in the City of Philadelphia for 100 years.

Continued on Page 44



Only the Thermoswitch* Control

solves

"push button" coffee maker's complex control problems

Automatically brewing coffee of the same high quality and unvarying flavor, regardless of climate or altitude, the new Cory "Push Button" Coffee Brewing System involves exact control of coffee, water and infusion time. Most important of all, the supply tank's electric heater must be turned on and off with precision accuracy so that water will be constantly available at the best coffee brewing temperature.

Tests proved that only a THERMOSWITCH* Thermostat possessed the extreme sensitivity and instant response necessary to meet the Cory Automatic Coffee Brewing System's exacting requirements and load conditions.

Throughout industry, rapidly increasing THERMOSWITCH* unit applications are putting temperature control on a more efficient, more economical basis. Chances are, a standard THERMOSWITCH* unit will be fully adequate for your own needs. You'll find the cost of *all* THERMOSWITCH* units surprisingly low! **MAIL COUPON TODAY!**

Fenwal

THERMOSWITCH*

*Reg. U. S. Pat. Off.

The Precision Thermostat For Temperature Control and Detection

SENSITIVE... *but only to heat*

FREE! Get this bulletin ... see what Fenwal Thermoswitch* units can do for *you.*

Just fill in coupon and mail... no obligation.

FENWAL, INCORPORATED, 54 Pleasant St., Ashland, Mass.

Temperature Control Engineers

Name ..... *Position* .....

Company .....

Street .....

City ..... *Zone* ..... *State* .....

I am chiefly interested in the applications checked:

HEATING
- ☐ Incubators
- ☐ Vulcanizing
- ☐ Pasteurizing

COOLING
- ☐ Refrigeration
- ☐ Ventilation
- ☐ Quick freezing

PROCESSING
- ☐ Canning
- ☐ Cooking
- ☐ Refining

SAFETY WARNINGS
- ☐ Engines
- ☐ Motors
- ☐ Transformers

DOMESTIC HEATING
- ☐ Limit switches
- ☐ Oil burners
- ☐ Hot water tanks

LABORATORY EQUIPMENT
- ☐ Ovens
- ☐ Cabinets
- ☐ Liquid baths

OTHER (Please fill in your special requirements)

.....

You can SKETCH it better, quicker, more effectively—

LEARN HOW IN

Technical Sketching

AND VISUALIZATION FOR ENGINEERS

You don't need a talent for drawing

This book shows you in easy-to-learn steps and hundreds of sample sketches how to acquire skill in freehand drawing; how to plan and execute accurate technical sketches of all kinds. You only need a pad and pencil.

"Recommended to all who work with mechanical designs or have engineering ideas to sell." —MECHANICAL ENGINEERING

You will learn to sketch quickly and accurately as an aid in developing ideas as well as in clarifying them to others in the shop, design conference, sales office.

Clear, explicit, filled with ideas and practical suggestions for short cuts, this book *"is a great help . . . Even the non-artistic can learn to make a presentable sketch."*—AMERICAN MACHINIST

Do you supervise people?

Working with People

WILL HELP YOU!

"Any man or woman whose prime responsibility is for the work of others cannot fail to profit from reading this book," says E. J. Lyons, V.P. for Personnel, Merck & Co. Here is sound psychology applied in the most brass-tack terms. Case by case, in situations occurring in every plant and office, this book shows you how to stimulate and use the best abilities of people, how to minimize the frictions and tensions that undermine good work.

"There are very few members of management at any level who will not meet themselves or one of their associates here," says Mr. Lyons. *"Any manager can recommend it."*

SEE THESE INVALUABLE BOOKS FREE

The Macmillan Co., 60 Fifth Ave., N. Y. 11

Please send me the books checked. I will either return them in 10 days or remit in full.

☐ **Technical Sketching, $5.**

☐ **Working with People $3.**

Signed .....

Address .....

CATALOG GUIDE

11 REVERSING VANE PUMPS

Brown & Sharpe Mfg. Co.—8-page Folder covers the new series of automatic reversing vane pumps, made as complete pumps or stripped models. It gives installation dimensions, specifications and price information as well as photographs and diagrams. They are designed for pressures up to 100 psi and are suited for supplying lubricating oil and comparatively clean coolant.

12 AIR CYLINDERS

Rivett Lathe & Grinder, Inc.—New 16-page Catalog is designed to help the engineer plan his air circuit. Drawings of typical circuits are furnished, showing best use of air equipment. Detailed dimensions are given for each model cylinder.

13 COLORBRITE THIN COLORED PENCILS

Eberhard Faber Pencil Co.—Introductory offer of one Colorbrite Pencil together with a folder. This sensationally new and different colored pencil is claimed to deposit "intense color with a feather touch". Amazing strength . . . guaranteed not to break in normal use. Wet-proof, smear-proof colors. Available now in Red, Blue, Green and Yellow colors.

14 AUTOMATIC FILTER AND SOFTENER MULTIPORT VALVES

Hungerford & Terry, Inc.—Bulletin V-1 illustrates and describes poppet type multiport valve for manual, semiautomatic or fully automatic operation of new or existing zeolite water softeners and water filters.

15 SPHERICAL ROLLER BEARING PILLOW BLOCKS

Fafnir Bearing Co.—10-page Catalog describes a new line of heavy duty pillow blocks equipped with Torrington self-aligning spherical roller bearings. Housings are of two-piece design, for oil or grease lubrication, felt or triple labyrinth seals. Booklet carries photos, sizes in adapter type or cylindrical bore mountings, load ratings, notes.

16 STEAM AND LIQUID CONTROLS

O. C. Keckley Co.—Catalog 49, Steam and Liquid Control Equipment, containing 48 pages. Valves, precision pressure regulating, relief and float; temperature regulators; self cleaning strainers; water gages, gage cocks; illuminators; steam traps and air separators are described. Includes dimensions, application, capacity list price and engineering tables and specifications.

17 MECHANICAL SHAFT SEALS, PACKING AND "O" RINGS

Crane Packing Co.—Three Bulletins available. "Bellows Shaft Seal" bulletin is illustrated with cutaway views, and shows typical installations and design characteristics. "O" Ring booklet covers ring materials, operating data and service recommendations. "Industrial and Marine Packing" catalog contains wide recommendations for Packing services in marine and industrial fields.

18 SLOW-SPEED COAL CRUSHERS

Pennsylvania Crusher Co.—8-page Bulletin 9001 describing in detail their Ring-Type Granulator for preparing pulverizer and stoker coals, various chemicals and minerals. Includes story of how Pennsylvania engineers developed "rolling compression", the Granulator's patented crushing action which results in less overgrinding, more granulation, slow speed, and lower power demands. Also included are shop and installation pictures, complete construction data, and a table of sizes and capacities.

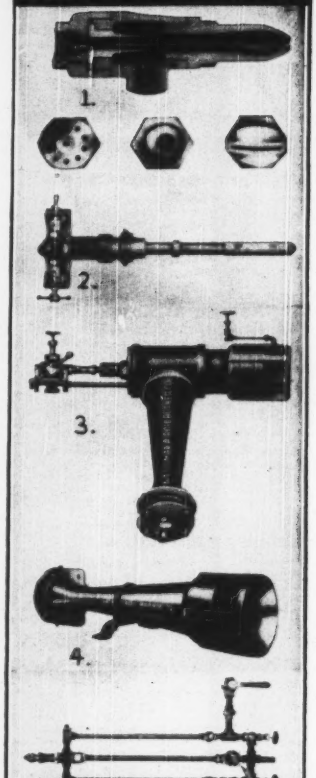
19 PYROMETERS

Leeds & Northrup Co.—Micromax and all other L&N plant instruments for measuring, recording and controlling temperatures detected by thermocouples are described in Catalog N-33A. Temperature instruments for use with Rayotubes are described in Catalog N-33B. For information on high-speed Speedomax Recorders for industrial temperatures, see Catalog ND46. Complete equipment for checking thermocouple pyrometers is listed in Catalog E-33A-503.

20 PAK-LOADER SYSTEM

Yale & Towne Mfg. Co.—New 4-page Bulletin describing the Pak Loader Fork Truck System of palletless handling. Illustrates the application of the Pak Loader System to the transporting and tiering of loads of sacks, cartons, bails and drums. This System will be of interest to those engineers having the problem of handling large quantities of goods that must be stored. The System also makes it possible to unload onto freight cars and highway trucks without rehandling.

THE *RIGHT* OIL BURNER OR GAS BURNER *FOR YOUR JOB*



TYPE "S-A"

1. (For use where steam is available) *atomises thoroughly* and *burns completely*, the lowest and cheapest grades of fuel oil and tar, requiring only low oil pressure and temperatures. Send for Bulletin #21.

TYPE "S-A-L"

2. (Large capacity burner similar to TYPE "S-A-R") is adaptable in combination with powdered coal burners in large boilers. Send for Bulletin #24.

COMBINATION GAS AND OIL BURNER

3. —the "AIROCOOL" Gas Burner in combination with a TYPE "S-A-R" Oil Burner. Send for "AIROCOOL" Brochure.

"AIROCOOL" GAS BURNER

4. (Of venturi type) assures low turndown without burnback. Send for "AIROCOOL" Brochure.

TYPE "S-A-D"

5. (Refuse Oil Burner) burns acids or caustic oils, sludges, asphalts, tank bottoms, polymer oils, heavy petrolatum, organic oil residuums, waste cutting oils, sulphite pulp liquors, etc. Send for Bulletin #21.

NATIONAL AIROIL BURNER CO., INC.

Main Offices and Factory
1239 E. SEDGLEY AVE., PHILADELPHIA 34, PA.
Southwestern Division: 2512 South Boulevard
Houston 6, Texas

CATALOG GUIDE

21 AIR CONDITIONING AND REFRIGERATION EQUIPMENT

Baker Refrigeration Corp.—Catalog No. 28A covers complete line which includes Freon Condensing Units 1-60 H.P., Ammonia Compressors 2-125 H.P., Bakeraire Self-Contained Air Conditioner 3-5 7½, 10 H.P., Central-Air central stationed conditioner 5-40 H.P., also complete line of Heat Transfer Equipment, Evaporative Condensers, Cooling Towers, Valves and Fittings, and auxiliary equipment for all types of air conditioning and refrigeration applications.

22 PIPELINE STRAINERS

Yarnall-Waring Co.—Bulletin on Yarway Fine-screen Strainers revised and enlarged to 6 pages. New edition S-203 includes details on screwed strainers up to 3", flanged strainers up to 5". Screen data, weights, dimensions and installation and maintenance suggestions.

23 POWER PRESSES—INCLINABLE, HORNING STRAIGHT SIDE

V & O Press Co.—Catalog available describing Inclinable Presses, Bench Presses, Double Action Presses, Punch Presses, Arch Presses, Horning and Wiring Presses, Reducing Presses, Foot Presses, Notching Presses, High Speed Presses, Straight Sided Presses, Automatic Roll Feeds, Dial Feeds, Feed-O-Matic (Punch Press Feeder), Automatic Threading and Trimming Machines.

24 METERS, REGULATORS AND VALVES

Rockwell Manufacturing Co.—Catalog C-5000 gives 20 pages of illustrations, descriptive literature and specifications of gas meters, gas pressure regulators, gasoline, oil and industrial meters, water meters and Nordstrom valves. It is designed to acquaint the consumer in a general way with the complete line of products.

25 CHAIN DRIVES

Morse Chain Co.—Packed with 32 pages of illustration and information, new Catalog C71-48 offers complete data on famous Morse Silent Chain. Features are: assembly and disassembly, explanation of the exclusive "Rocker Joint", service factors, stock sprocket data, drive design, selection tables, installation and maintenance, and many other important topics.

26 SINGLE STAGE TURBINE PUMPS

J. S. Coffin, Jr., Co.—Bulletin "S", a 4-page illustrated folder, describing the construction and operation of High Speed Single Stage Turbo Pumps, offered for Steam Pressures to 850 P.S.I., Back Pressures to 200 P.S.I., Pump capacities to 700 G.P.M., Discharge Pressures to 1100 P.S.I., Liquid Temperatures to 300°F.

27 FLAT LAPPING

Crane Packing Co.—12-page Booklet, fully describing the new "Lapmaster" method of flat lapping to extremely close tolerances on an automatic, high production basis. Photographs, diagrammatic drawings and complete data on "John Crane" Lapmaster Models "12" and "24" provide profitable information for all industries whose manufacturing operations include finishing parts to precision surface flatness and finish.

28 ELECTRIC MOTORS

Howell Electric Motors Co.—"Red Band" Motors customers' price Catalog available and also descriptive bulletins separately describing motor types including general purpose squirrel cage induction motors totally enclosed, elevator motors, explosion proof, multi-speed and sanitary motors and also a bulletin on fractional horsepower ratings. Also condensed price sheets and bulletins AC-2 are available, the latter listing recommendations for various types of motors used on typical applications. The Company specializes in industrial A. C. Motors from ¼ to 150 horsepower.

29 JAW CRUSHERS

Pennsylvania Crusher Co.—New 12-page Bulletin 50-2, presents the Kue-Ken Jaw Crusher, an advanced design featuring a patented "Crushing Without Rubbing" action. In comparison with old-style single or double toggle jaw crushers, the Kue-Ken offers the operator 2 to 5 times greater capacity, 5 to 10 times longer jaw plate life, and much less power demand per ton crushed. Includes complete data on construction, performance, and installations. Contains many photographs, diagrams, and engineering drawings plus easy-to-read tables.

30 FILTERS AND STRAINERS

Cuno Engineering Corp.—Completely revised Catalog of filters and strainers . . . the answer to nearly any fluid conditioning problem. Catalog contains

Continued on Page 46

ACTUAL CHECK PROVES

No other Copying Process offers you

OZALID'S ECONOMY!

HERE'S PROOF!

See how 4 other most popular copying methods compare with the money-saving versatility of Ozalid.

	OZALID	METHOD A	METHOD B	METHOD C	METHOD D
Prints ready for immediate use	✓	✓	✓		✓
No size restrictions	✓			✓	
No special plates, stencils, or inks	✓			✓	
No need to make negative	✓	✓	✓		✓
Additional copies immediately available	✓				
Easily makes duplicate masters	✓				

WHAT IS OZALID?

• Ozalid is a *speedy copying process* that uses sensitized paper to reproduce anything typed, drawn or written. You get perfect copies of letters, records, reports, photographs, index files, drawings—anything.*

WHAT ARE THE ADVANTAGES OF THE OZALID PROCESS?

• **No size restrictions**—Ozalid copies can be made in *any* size, in sheets or continuous rolls.

• Copying errors are eliminated. There's no *check-back* to the original.

• Changes easily made. Add new material to create a "composite master". No need to re-create an entire piece.

OZALID PAPER IS UNEQUALLED FOR QUALITY, TOO!

• For years, Ozalid has been established as the "Standard of Quality" among sensitized papers.

• Ozalid's "speed" is the same, month in and month out—stepping up production.

• Controlled product quality gives more prints at lower labor cost.

• Longer shelf-life—means less waste.

Imagine asking for "ten copies in three minutes" . . . and getting them. Thus releasing your typists for important work, while a file clerk runs the machine!

You get dry, positive, exact duplicates in a fraction of a minute and at a fraction of your usual cost.

**If light won't shine through, an inexpensive intermediary step is taken.*

Cut Copying Costs...Use

OZALID!

OZALID, Dept. K2
Johnson City, New York

Gentlemen: Please send free illustrated booklet that fully explains the Ozalid process.

Name .....

Company .....

Address .....

Or call your local Ozalid distributor listed in the classified telephone book.

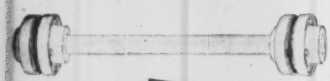
A DIVISION OF GENERAL ANILINE & FILM CORPORATION. "FROM RESEARCH TO REALITY"

THOMAS
Flexible ALL METAL COUPLINGS
FOR POWER TRANSMISSION REQUIRE NO MAINTENANCE

Patented Flexible Disc Rings of special steel transmit the power and provide for misalignment and end float.

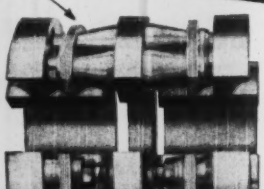
Thomas Couplings have a wide range of speeds, horsepower and shaft sizes:
½ to 40,000 HP
1 to 40,000 RPM

Specialists on Couplings for more than 30 years



BACKLASH FRICTION WEAR and CROSS-PULL are eliminated
Lubrication is not required!

PATENTED FLEXIBLE DISCS



THE THOMAS PRINCIPLE GUARANTEES PERFECT BALANCE UNDER ALL CONDITIONS OF MISALIGNMENT.
NO MAINTENANCE PROBLEMS.
ALL PARTS ARE SOLIDLY BOLTED TOGETHER.

Write for the latest reprint of our Engineering Catalog.

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA

CATALOG GUIDE

complete specifications, including engineering drawings, for all standard models. Principles of construction and operation described and illustrated.

31 SEAMLESS WELDING FITTINGS AND FORGED STEEL FLANGES

Tube Turns, Inc.—Chart of Pipe and Fittings Materials. Quick reference chart covering ASTM and other specifications, Chemistry, Service Temperature Limits and Welding Data on carbon, intermediate alloy, stainless and special analysis steels, Dimensional Data and Weights. Folder of man-size tables giving dimensional information on Tube-Turn welding fittings from ⅛" to 30" in standard weight and extra strong, and flanges in all sizes and weights. Allowable Working Pressures. Booklet of pressure tables covering complete line Tube-Turn welding fittings for Power Piping, Oil Piping, Heating Piping, Gas Piping, Refrigeration Piping.

32 COMPRESSOR VALVES

J. H. H. Voss Co.—Voss Valves are applicable to any make, size and type of air, ammonia, or gas compressor; are supplied to manufacturers of new machines, as well as to users, for replacing inefficient, unsatisfactory or worn out valves. Designed skillfully for each individual job, made on special machinery from alloy or stainless steel, they are unsurpassed in efficiency, reliability, and safety. Literature explains how and why Voss Valves offer great improvement over obsolete valves or cheap cast iron plate or ribbon valves.

33 PORTABLE PNEUMATIC TOOLS

Cleco Div., Reed Roller Bit Co.—Catalog 47 shows the complete line of Cleco Pneumatic Riveters, Chippers, Drills, Grinders, Sanders, Rammers, Screw-drivers, Impact Wrenches, Contractors' Tools and Hose Fittings and Accessories.

34 TURBINES—MECHANICAL DRIVE

Westinghouse Electric Corp.—Booklet B-4316, "Westinghouse Gearturbines," presents a line of close-coupled geared turbine units, combining the Westinghouse Type E Turbine with a rugged, compact speed-reduction unit solidly coupled on a unique combination oil reservoir and base. Important features such as dual overspeed protection, weather and dirt-proof bearing seals, center line support and free expansion, single helical gearing, three-point support for ease in leveling and aligning, and maintenance saving refinement are explained in detail. An ample range of standard gear ratios and choice of 16, 20, and 25 inch wheel sizes, with choice of governors, enabled the Westinghouse Gearturbine to meet a variety of applications, discussed in this booklet, with attractive price savings over flexibly coupled gear drives. Wheel sizes, gear ratios, weights and dimensions are conveniently tabulated for reference.

35 DOWEL PINS

Standard Pressed Steel Co.—Shop Equipment and Screw Products manufacturers. Latest "Unbrako" Dowel Pin Bulletin. This attractive 4-page bulletin contains standard and suggested uses for "Unbrako" Precision-Ground Dowel Pins, with accompanying application illustrations. Pertinent data as to "Unbrako" Dowel Pin specifications, packaging, etc., is also included.

36 PREHEATED NO. 5 OIL BURNERS

Petroleum Heat & Power Co.—Petro Model W-A-F, described in Bulletin 150-A, provides highly efficient combustion for No. 5 oils requiring some preheating — viscosity range from 300 S.S.U. to 100° F. up to 40 S.S.F. at 122° F. Available in direct or belt driven motor types, for all electrical characteristics, capacities up to 100 gph; full or semi-automatic, or manual operation; fixed, compound or modulated firing.

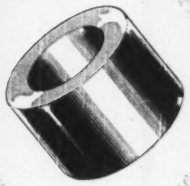
37 BALL BEARINGS

New Departure, Div. of General Motors—Supplementing its standard Catalog, a series of five books, helpful to the engineer and designer in applying ball bearings to any new machine. The first book deals with principal bearing types and fundamentals of mounting practice, the second, details of shaft and housing designs, and the third, enclosure and lubrication for varying operating conditions; the fourth book gives a new simplified method of computing bearing loads, while the fifth entitled, "Application Procedure," outlines the necessary steps in obtaining assured bearing performance.

38 STEAM GENERATORS

Erie City Iron Works—40-page Bulletin showing construction details of all the component parts of the Erie City Steam Generator. Boiler, water walls, superheater, and heat recovery equipment are pictured and described as well as the Erie City Steam Purifier and Scrubber. There are also included cross sections of actual installations over a wide range of capacities.

WORKS WHERE OTHERS WON'T



accurately formed

GRAPHALLOY OILLESS BEARINGS

SPECIFY GRAPHALLOY
TRADE MARK REG. U.S. PAT. OFF.

WITH CONFIDENCE

SELF-LUBRICATING ○ EXTREMELY DURABLE ○ CONSTANT CO-EFFICIENT OF FRICTION ○ OPERATES DRY — OR SUBMERGED IN WATER, GASOLINE OR CORROSIVE LIQUIDS ○ APPLICABLE OVER A WIDE TEMPERATURE RANGE — *even where oil solidifies or carbonizes* ○ EXCELLENT AS A CURRENT-CARRYING BEARING.

GRAPHITE METALLIZING CORPORATION
1058 NEPPERHAN AVENUE, YONKERS 3, NEW YORK

CATALOG GUIDE

39 BALL BEARING SWIVEL JOINTS

Chiksan Co.—48-page Catalog No. 44 illustrates and describes complete line of over 500 different Types, Styles and Sizes; with data on dimensions and weights. Revised Catalog No. 50 also available. 4-page Bulletin covers Sanitary Swivel Joints. 12-page Bulletin covers Aircraft Swivel Joints.

40 MOTOR SPEED CONTROL

General Radio Co.—Literature describing a new variable speed motor control. Continuously variable speed range of over 15 to 1 is available with smooth operation at all speeds. Dynamic braking and reversing is provided. All control equipment and circuits are in one small, easily mounted metal box.

41 FLOAT VALVES

O. C. Keckley Co.—Have ready for distribution a new, illustrated Bulletin on their No. 14 Single Seat and No. 15 Balanced Float Valves, and their No. 20 Float Boxes with Control Valve. Also No. 49 Catalog of steam and liquid control equipment.

42 VIBRATION FATIGUE TESTING MACHINES

All American Tool & Mfg. Co.—Bulletin 310 on All American Vibration Fatigue Testing Machines. Fully describes, illustrates and gives specifications on models for every requirement. Explains the principles which make vibration fatigue testing with an All American machine authentic. Contains a representative list of users, which includes the leaders of American industry.

43 STOKERS

Detroit Stoker Co.—Bulletins covering complete line of Detroit Underfeed and Overfeed Spreader Stokers. Detroit Stokers are unsurpassed for their economy and dependability. Features embodied in the various designs represent over fifty years of experience in stoker manufacture exclusively. As builders of both underfeed and overfeed spreader stokers of many types, sizes and capacities, they are in a position to recommend the kind of stoker best suited for any individual requirement. All grades of bituminous coal are successfully burned without expensive preparation. Operating costs are low, plant efficiencies may be raised to new standards and the capacities of present boilers increased through the use of Detroit Stokers. Proper design and application by experienced builders will produce best results.

44 FLEXIBLE COUPLINGS

Poole Foundry & Machine Co.—Flexible coupling Catalog No. 44 just off the press descriptive of all designs, types, of gear type flexible shaft couplings for both light and heavy duty drives. Various designs such as standard, mill motor, heavy duty mill drives, floating shaft or extended types, single engagement types, vertical, shear pin, Jordan, disengaging, continuous lubricating, and other special types listed and shown with horsepower ratings, dimensions, etc.

45 UNITIZED CONVEYOR TABLES

Island Equipment Corp.—Bulletin IP-1A describes company's versatile conveyor table. The Unitized Conveyor Tables are available for stationary or portable work for inspecting, assembling or packaging. Can be had in any of eleven widths and any length in multiples of 10′ up to 100′. This bulletin gives complete details and shows many applications in use.

46 STEAM PLANT EQUIPMENT

Yarnall-Waring Co.—Revised issue of 12-page Bulletin on Yarway steam plant equipment. New edition G-1307. Covers blow-off valves, water columns and gages, liquid level indicators and recorders, expansion joints, steam traps, pipeline strainers and spray nozzles. Sectional illustrations show design features of each product.

47 ROLLER BEARINGS

Hyatt Bearings Div., General Motors Corp.—New 35-page Hyatt Handbook "Guide Lines for Engineers and Designers." A guide to the proper application of cylindrical roller bearings in machinery and equipment of all types. With design drawings of successful, tested applications, it illustrates the fundamental needs which must be provided for in the machine designed: namely—retainment, shaft location, housing, lubrication seals and closures.

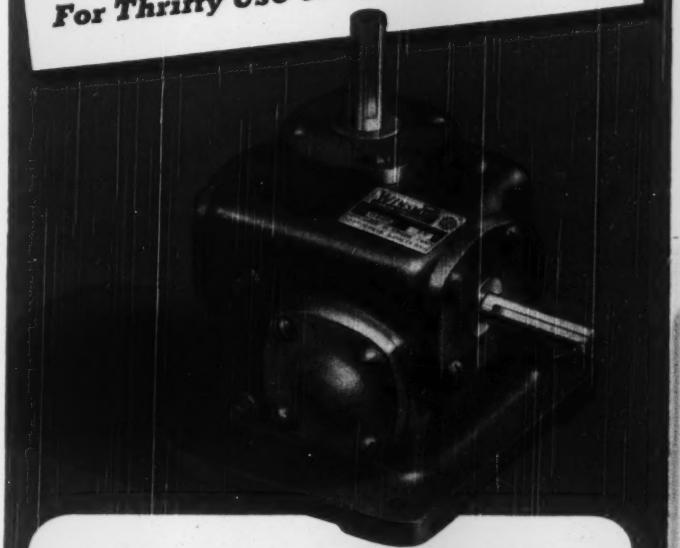
48 RECIPROCATING PUMPS

Aldrich Pump Co.—New Data Sheet 64 illustrates and concisely describes the new design and advantages of the 5" Stroke Direct Flow Triplex Pump. Information includes specifications, dimension

Continued on Page 48

NEW SPEED REDUCTION PACKAGE

For Thrifty Use of Space and Power



From a reducer originally designed to serve the low power, confined area requirements of moving merchandise displays weighing up to 1500 lbs., the new Winsmith Type DBRA now shapes up as one of the most versatile designs ever created for *any* duties involving transmission of small power loads.

For the countless applications calling for use of 1/20 to 1/8 horsepower, designers and users were formerly obliged to sacrifice space, weight and money by specifying large, expensive speed reducers with power ratings of 50 or 100 times that required of them.

In your plant, or on the products you make to sell, there are perhaps many instances where the unique features of this newest addition to the Winsmith line can be applied, to your immediate and continuing profit. For here is the lightweight speed reduction package that is engineered to fit . . . the only such vertical, worm gear type that offers the power rating you want in 23 different shaft locations and in reduction ratios of 25:1 to 1764:1.

But DBRA may not be the only type required for improving the productivity of your equipment or the salability of your products. If that's the case, virtually any speed reducer your needs may dictate can be selected from Winsmith, the world's most complete line. Without obligation to you, a Winsmith transmission engineer will not only aid you in your selection, but will review your present or projected power transmission systems to help create for you the kind of success story told of so many Winsmith users — verified stories that feature the achievement of better service, lower cost and higher sales. Write . . . ask, without obligation.

★ DESCRIPTIVE LITERATURE on new type DBRA, as well as Catalog-Handbook *free on request.*

SEND FOR CATALOG 19

WHS WINSMITH SPEED REDUCERS

WINFIELD H. SMITH CORPORATION

333 June St., Springville, Erie County, New York

NO OTHER COMPRESSOR VALVE OFFERS YOU ALL OF THESE ADVANTAGES

1 LARGER GAS PASSAGE AREA
From 20% to 100% increased valve area handles more and colder gas; a colder therefore denser gas costs less to compress.

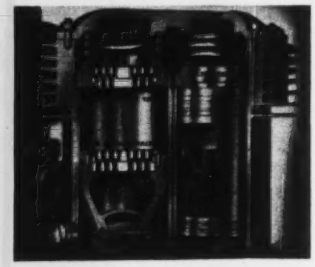
2 LARGER VALVE AREA
Raises back and lowers head pressure, consequently reduces compression ratio—saving more power.

3 NOISELESS
Smooth running—with less power—at higher speeds without overheating.

4 SAFE
No castings used—therefore no invisible blow-holes or cracks which insures safety of operation. Gas passages drilled, slotted and milled smooth—hence less friction.

5 LONG LIFE
Made to the highest standard of workmanship—on special machines—by craftsmen—in a modern and well equipped shop—designed to give long life under the severest conditions.

LET US SHOW YOU WHAT VOSS VALVES CAN DO FOR YOU
We will be glad to submit estimates if you will send us the name, bore, stroke and speed of your air, gas, or ammonia compressors of any type or size.

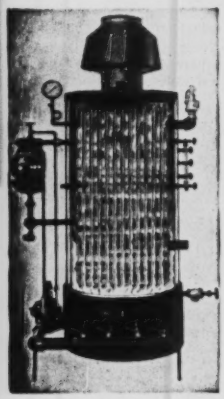


VOSS
LONG LIFE
COMPRESSOR
VALVES

VOSS VALVES are indispensable for use where loads are heaviest—where safety and reliability are paramount. They run smoothly—with less power—at higher speeds—without overheating. You can replace your present valves with VOSS VALVES without any change in your compressor.

J. H. H. VOSS CO., Inc. 785 East 144th Street NEW YORK 54, N. Y.

WILL YOU HAVE Steam FOR PROCESSING NEXT SUMMER?



The KANE Boiler is built to A.S.M.E. specifications, in sizes to 30 H.P.

Will your central steam system be shut-down next summer? If so, act now to insure an independent, *dependable* source of Summer Steam for your processes—we would suggest . . .

the Kane Boiler Package

Each KANE BOILER PACKAGE is carefully considered by us as an "individual" job—from the customer's requirements to the finished unit. And each BOILER PACKAGE is a compact, self-contained steam source that includes: the correctly sized KANE Automatic Gas-Fired Boiler complete with gas burner and controls to maintain required steam pressure; and an M-K-O Automatic Boiler Feed system designed to return condensate and supply make-up water as required for highest operating efficiency.

Engineered Steam at its best with four decades of experience at your disposal—so, send your steam problem to us for study and recommendation.

ENGINEERED STEAM AT ITS BEST

MEARS-KANE-OFELDT INC.

1903-1915 EAST HAGERT STREET, PHILADELPHIA 25, PA.

FOUR DECADES OF AUTOMATIC GAS-FIRED BOILER MANUFACTURING EXPERIENCE

CATALOG GUIDE

drawings, selection chart and tables, and drive specifications. The Series is built in 3, 5, 7 and 9 cylinder units; ranges from 75 to 275 hp; provides pressures up to 7500 psi; and handles up to 6400 bbl per da yat 100 rpm.

49 CONVEYOR CHAINS AND SPROCKETS

Diamond Chain Co., Inc.—Diamond Conveyor Chains and Sprockets are fully illustrated and described in a new 28-page Bulletin No. 29 just released for distribution. The Chains are made in pitches ranging from 1" to 4" with standard and large rollers. Standard attachment links, extended pins, stainless steel bronze and top plate chains along with appropriate Sprockets are also described.

50 CAR SHAKERS

Link-Belt Co.—12-page, illustrated Book No. 2345 on new Car Shaker, a compact, self-contained vibrator unit for rapid, economical unloading of bulk granular materials from open top, hopper bottom gondola cars to conventional track hoppers serving conveying equipment. Particularly recommended for unloading coal, sand, coke, ore, gravel, cinders, etc., and accelerating removal of damp materials frozen in cold weather.

51 HIGH VACUUM APPARATUS

Central Scientific Co.—Booklet on their various high vacuum apparatus. Included in this 48-page pamphlet are suggestions for planning a high-vacuum system; information on pumping speed; explanation of merit factor, connections and speed of evacuation, low pressure technique, and other data, together with a complete listing of Cenco mechanical pumps, D-P diffusion pumps and Cenco gages, oils, traps, and other vacuum accessories, including the New Hypervac 100 Pump with ultimate vacuum of better than 0.1 (often 0.02) micron of mercury.

52 METAL WORKING TOOLS

T. H. Lewthwaite Machine Co.—Revised and enlarged set of Catalog Sheets listing the extensive and ever-increasing standard range of punches and dies of many styles and sizes which they manufacture and stock for immediate shipment. Their hand operated punches, cutters, and benders are also illustrated and described.

53 WATER TUBE HEATING AND POWER BOILERS

International Boiler Works Co.—Catalog and Specification Sheet describing Water Tube Steel Heating and Power Boilers, includes pictures and cuts showing effective baffling arrangements which provide economical performance with all fuels and any method of firing. Made in standard sizes from 10 to 600 B.H.P. See our data in A.S.M.E. Mechanical Catalog.

54 MECHANICAL VACUUM PUMPS

Kinney Manufacturing Co.—High Vacuum Pump Bulletin V45 contains the latest technical information on the design and operation of Kinney High Vacuum Pumps. Complete reference tables and engineering data are given, together with information on the installation of vacuum systems and the selection of the proper pump and accessories. The catalog, fully illustrated in color, will prove a helpful guide to all those interested in the rapidly expanding field of vacuum processing.

55 GASKETS

Metallo Gasket Co.—Catalog on metal, metal asbestos gaskets and metal Tower Packing engineered to meet the demands of Chemical Industries, Oil Refineries, Power Plants, Air Conditioning, industry, and equipment manufacturers.

56 AIR PREHEATERS

Air Preheater Corp.—The first section of their Catalog on Ljungstrom Air Preheaters presents an over-all picture of the Ljungstrom, its functions and operation. Examples of installations of the Ljungstrom continuous counterflow regenerative type preheater, covering a range of diverse applications, are shown in diagrammatic form, together with photographs of the Ljungstrom in sufficient detail to make its principle and operation clear.

57 STEEL BOILERS

Kewanee Boiler Corp.—Kewanee Type "C" Steel Boilers of the welded Hi-Firebox series are shown in 8-page Catalog 97. This includes the mechanically fired 71-70 Hi-Firebox and the 271-70 series having grates for hand fired coal with conversion possibilities. 18 sizes . . . 2200 to 42,500 sq ft of radiation.

58 GEARS

Earle Gear & Machine Co.—Catalog describes the facilities and services offered by Earle in the cutting of gears of all types from any practical material in

CATALOG GUIDE

diameters from inches up to 30 feet and in the design and manufacture of special operating machinery for dams, locks, bridges and similar installations. The catalog is profusely illustrated with photos and drawings and contains tables, rules and formula and ordering information.

59 DUST COLLECTORS

Northern Blower Co.—Automatic Bag Type Dust Collectors for heavy duty continuous service are described fully in Bulletin 164-2. This equipment is designed for constant volume of air handled and constant static loss. Norblo dust collector operates at constant efficiency and capacity. The cleaning style can be varied for different dust loading in a few minutes without shutting down. Any compartment can be cut out of action for repair or maintenance and all other compartments will continue in operation indefinitely. Norblo collectors, including fans, are completely fabricated by them.

60 SCREW THREAD INSERTS

Heli-Coil Corp.—Bulletin No. 248 illustrates and describes the uses of Heli-Coil screw thread inserts for strengthening and protecting screw threads in all metals, plastics, wood and ceramic materials. Text of this 12-page bulletin contains specifications for all National Coarse and Fine Threads, and Taper Pipe Thread, together with data on design and installation.

61 STEAM CLEANERS

Homestead Valve Mfg. Co.—"1001 Ways to Extra Profits with Hypressure Jenny" is the title of the new 20-page Catalog recently issued. It contains over 30 photographs of the units doing cleaning jobs in a variety of different fields. The booklet also describes the models in the Hypressure Jenny line.

62 STOKERS

Westinghouse Electric Corp.—Booklet B-3039, "Westinghouse Link-Grate Continuous Ash-Discharge Stokers, Type SDL" presents the Westinghouse multiple-retort underfeed stokers with the famous Link-Grate. High combustion efficiency attained by effective coal and air coordination, achieved by means of an undulating grate surface synchronized with coal feed, is explained in detail. Flexibility in application is documented with copious reference to actual installations, with diagrams and application data.

63 MATCHED MOTOR PARTS

Robbins & Myers, Inc.—Catalog Series 400. Here's the complete guide to modern motor application. A fully-illustrated, 36-page handbook with explode views and detailed drawings which solve many powering problems. Specifications, sizes, and performance characteristics of component parts for all motor types and requirements. A ready reference manual that will prove especially helpful to design and product engineers.

64 GRATING—FLOORING, SAFETY TREADS

Irving Subway Grating Co.—Catalog No. F-225 contains illustrations, descriptions and engineering data on fireproof, durable, safe, clean and economical Gratings and Safety Steps (riveted, pressure-locked and welded) for Industrial Plants, Power Plants, Refineries, Ships, Railroad Freight and Passenger Cars and Locomotives, Open Steel-Mesh Bridge Decking, etc.

65 STEAM TURBINES

Terry Steam Turbine Co.—Bulletins in loose-leaf form which cover a complete description of Terry solid wheel turbines with cross-section drawings of typical units for both moderate and high steam pressure conditions; a description of the Terry axial flow impulse, both singlestage and multistage. Terry gears are used for speed increasing and speed reducing.

66 FLEXIBLE COUPLINGS

Thomas Flexible Coupling Co.—The latest engineering information on Thomas Flexible Couplings is contained in their Engineering Catalog, which shows their complete lines of single and double types of All Metal flexible couplings for heavy duty impulse loads such as Diesel driven compressors, as well as for smooth loads such as motor driven centrifugal pumps.

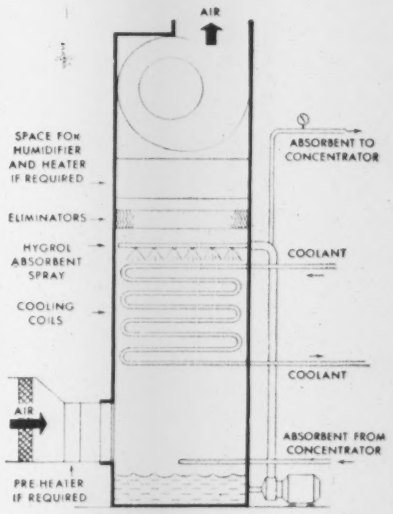
67 KEY TO REMOTE CONTROL

Automotive & Aircraft Div., American Chain & Cable Co.—Booklet "The Key to Remote Control." Tru-Lay Push-Pull Controls. Built as precise machine parts for handling push or pull loads from 30 to 1,000 lbs. Quality controls of long life. Operative in extreme low temperatures as well as normal temperatures. Standard parts available for making most installations with the exception of length which can be varied. Suitable for use in extreme long lengths.

Continued on Page 50

New Method Gives Precise Control in Air Conditioning

Niagara "Controlled Humidity Method" Uses Hygrol, Hygienic Liquid Absorbent

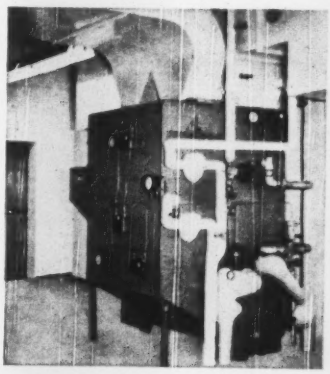


NIAGARA CONTROLLED HUMIDITY METHOD — FLOW DIAGRAM

● The Niagara "Controlled Humidity Method" is a new system of air conditioning giving complete control of temperature and relative humidity, holding constant conditions or varying them at the will of the user. Especially, it provides dry air at normal atmospheric temperatures with little or no refrigeration required. A condition of 15 grains of moisture per pound of air at 85 deg. F. dry bulb temperature has been produced without refrigeration.

The apparatus is enclosed in a casing thru which the air is drawn by fans. The air is filtered and then enters a chamber where it is dehumidified in passing thru a spray of "Hygrol" Liquid (a hygienic hygroscopic chemical that absorbs the air-borne moisture and contains no salts or solids to precipitate). In the same chamber are located cooling coils which remove the latent heat of evaporation and also sensible heat as required.

The absorbent liquid spray falls into a tank at the base, where it is piped to a concentrator, removing moisture taken from the air. The re-concentrated liquid returns to the system. This process is continuous, and the apparatus operates at full capacity at all times.



The same equipment may be used to provide winter air conditioning when required, by installing a tempering coil at the outdoor intake, an humidifier, and a reheat coil above the eliminators.

This equipment is manufactured in a range of sizes providing from 1000 to 20,000 CFM of conditioned air from a single unit, and mutiple unit installations are practical. It is expected that, by reducing the need for refrigeration, the cost of air conditioning will be reduced by this method. Applications generally are in a temperature range from 35 deg. F. upward. Below the freezing temperature of water, the Niagara "No-Frost" method is applicable.

The equipment is protected by U. S. and foreign patents. Installations have been made in food and chemical process industries, in packaging hygroscopic products, for preventing condensation of moisture on metals and other products in storage, in air conditioning for laboratory control and for human comfort.

For further information, write Niagara Blower Company, Dept. ME, 405 Lexington Ave., New York 17, N. Y.

You can work them harder...

...but don't make them sweat★

Molybdenum high speed steels are in many ways superior in performance to the equivalent tungsten steels, the main difference between them being that they require a somewhat different heat treatment.

Hardening temperatures are lower—operating costs are reduced—fuel is saved—furnaces and baths last longer and require fewer repairs.

MOLYBDENUM HIGH SPEED STEELS

★Many toolhardeners judge the correct high-heat hardening temperature for tungsten (18-4-1) high speed steels by the appearance of 'sweat' on the surface. This rough and ready test is not applicable to Molybdenum high speed steels, which harden at lower temperatures. Our free booklet gives full information on heat treatment.

Climax Molybdenum Company
500 Fifth Avenue · New York City

MAIL THIS COUPON

Please send me a copy of your FREE BOOKLET

Name .....

Company .....

Address .....

MOLY

ME 4

CATALOG GUIDE

68 PLATE PRODUCTS

Fitzgibbons Boiler Co.—Folder on plate products (Catalog P P.) describes and illustrates the facilities for fabricating carbon steel weldments in the Oswego plant of this company. Various products made under U-69 are illustrated also. Let the skill of more than 60 years help you on your plate fabrication problems.

69 WATER TUBE BOILERS

Babcock & Wilcox Co.—Bulletin G-62, the B&W Stirling Boiler, describes the application of this unit for all types of power and industrial services in a wide capacity range. The adaptability of this boiler to many furnace designs and any fuel or method of firing is described and illustrated. Close control of superheat and steam separation are discussed. A fully-labeled drawing of pressure parts explains the features of this boiler.

70 CENTRALIZED LUBRICATION SYSTEMS

Farval Corp.—"Studies in Centralized Lubrication, 1950"—presenting a series of case studies. Farval is a positive mechanical method of delivering oil or grease under pressure to a group of bearings in exact measured quantities. Eliminates guess work of hand lubrication and insures constant operation of machines without shutdown to lubricate or for bearing repair.

71 THERMOSTATIC STEAM TRAPS

Sarco Co.—A stainless steel element for pressures to 300 psi and for corrosive condensate is a feature of the new line of Sarco thermostatic steam traps. Condensate and air venting capacities of all traps are practically doubled, thru a new design which permits traps to reach rated capacities with a drop from steam temperature of only 10° F. New Bulletin 250-A.

72 MINIATURE BALL BEARINGS

Miniature Precision Bearings, Inc.—New 8-page Catalog, illustrated with comprehensive specifications on more than 40 types and sizes of standard miniature ball bearings from 2mm to $^{3}/_{16}$" outside diameter. Includes material of particular interest to designers of precision mechanisms—applications, lubrication, design variations, special bearings, etc.

73 PIPE HANGERS

Grinnell Co.—90-page Catalog of malleable, cast, wrought, steel and spring hangers has been arranged to simplify the selection of complete hanger assemblies. Contains helpful information for making spring hanger load calculations. Abundant miscellaneous material makes it an essential reference volume.

74 O-RINGS

Linear, Inc.—Compact 6-page Folder contains tables of standard O-ring sizes as well as dimensional data for installation. Notes give general recommendations on clearances, design, material, machining and finishes for most O-ring applications. A special compound bulletin containing descriptions of the latest polymers and synthetic rubbers from which O-rings can be moulded is also included.

75 PRESSURE GAGES

Helicoid Gage Div., American Chain & Cable Co.—Just released, new 16-page Helicoid Gage Catalog. The Helicoid Gage is the only pressure gage with the Helicoid Movement. It is guaranteed accurate to within $^{1}/_{4}$ of 1% of the total dial graduation over the upper 95% of the 280° dial arc. This means that on a 100 lb. dial, for example, accuracy is guaranteed to within $^{1}/_{4}$ lb. over the entire scale except from 0 to 5 lbs. A newly designed adjusting mechanism, located in the rear of the gage, makes possible recalibration without removing the pointer and the dial. This is a feature industry has long been looking for. Cutaway photographs and line drawings show the complete line of Helicoid Gages, how they work, what goes into them, how they're put together, and the reason why they're so accurate.

76 LUBRICATION

Lubriplate Div., Fiske Bros. Refining Co.—Announces the release of a new 44-page Lubriplate Data Book 1-50 which contains some very valuable information on the subject of lubrication.

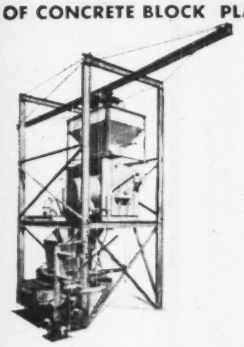
77 WORM GEAR SPEED REDUCERS

D. O. James Gear Mfg. Co.—24-page illustrated Catalog No. 40-S, containing valuable informative engineering data and prices on Single and Double Worm Gear Reducers. Type 'S' or Single Reduction come in 24 sizes, in ratio ranges of 5.66:1 to 100:1 and from .04 to 15 horse-power. Double Worm Gear Reducers are available in 10 sizes with ratio ranges of 87:1 to 10,000:1 and from 106 inch

LEDEEN CYLINDERS ARE GOOD CYLINDERS • LEDEEN CYLINDERS ARE GOOD CYLINDERS • LEDEEN CYLINDERS ARE GOOD CYLINDERS

Ledeen
heavy duty cylinders helped do this job *better*

SPEEDING OPERATION OF CONCRETE BLOCK PLANT



APPLICATION—Concrete material, used in making blocks, must be drawn from hopper, accurately metered, transported and fed to the block mold. A Ledeen heavy duty cylinder, 3" diam. x 20" stroke performs these operations in one motion. Action is simple, controlled by a hand valve.

OPERATION—The actuating cylinder, air-operated, moves a sliding feed box under the hopper, where it is filled with a measured amount of mix. It then slides the feed box forward delivering mix into the molds.

Perhaps you too have a job that can be improved by Ledeen heavy duty cylinders.

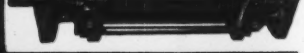
Wherever you have to...

PUSH OR PULL, LIFT OR LOWER, PRESS OR SQUEEZE, TILT OR TURN, OPEN OR CLOSE,

Ledeen heavy duty cylinders, operated by air, oil or water, will do it for you better and surer.

Standard Ledeen Cylinders with rod or head attachments are available from distributors' stock in major cities. Special cylinders on order.

Write for Bulletin 453.



Ledeen Mfg. Co.
DIV OF ENGINEERING PRODUCTS CO
1600 SAN PEDRO • LOS ANGELES 15, CAL.

CATALOG GUIDE

pounds to 3480 inch pounds output torque. Stock sizes, available for immediate shipment, are plainly indicated.

78 TURBINES—MECHANICAL DRIVE

Westinghouse Electric Corp.—Booklet B-3896, "Westinghouse Type E Turbines," describes the Westinghouse line of Type E General-Purpose Turbines, available in 16, 20, and 25-inch wheel sizes, for application from 5 hp through 1500 hp. Unique features of center line support, interchangeable parts, dual protection, and reduced maintenance are explained in detail. Accessories available for adaptation to special requirements are likewise presented. Helpful information on which turbine to buy, and why, and selecting the right wheel size to fit a particular application most economically, is included.

79 ROTARY SWIVEL JOINTS

Barco Mfg. Co.—Catalog No. 262 describes the new Rotary Swivel Joint for use on swivel and slow rotating applications up to 30 RPM. It has very low turning torque even at extreme temperature and pressure ranges. Provision for angular flexibility eliminates side strain. It is compact, light in weight and is low in cost. Standard models handle 300# working steam pressure, extra heavy models 600# steam and 2500# hydraulic. ¼" to 2" pipe sizes.

80 CLUTCHES AND POWER TAKE-OFFS

Rockford Clutch Div., Borg-Warner Corp.—Handy Bulletin on Power Transmission Control. It shows typical installation of Rockford Clutches and Power Take-Offs. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications. Every production engineer will find help in this handy bulletin when planning his new products.

81 POSITIVE DISPLACEMENT BLOWERS

Standard Stoker Co.—Bulletin No. 84, new type of Positive Displacement Blower. The blower has wide applications in industry and is available in capacities from 100 to 15,000 cfm and for pressures up to 20 pounds. Unique features of the blower are its quietness of operation, its greatly reduced weight over similar blowers, and its compactness. A 2000 cfm Standardaire Blower weighs approximately 1000 pounds. Because it may be operated at high speeds the blower lends itself to direct drive by standard motors.

82 ALL PURPOSE COPYING PROCESS

Ozalid, Div. of General Aniline & Film Corp.—4-page illustrated Folder briefly explaining the story of Ozalid . . . the modern, speedy way to copy anything typed, drawn, or written. Contains a graphic explanation of the process; complete machine specifications and descriptions; and a brief description of the type of sensitized materials available together with their recommended uses.

83 TRAPS FOR REMOVING WATER FROM COMPRESSED AIR

Armstrong Machine Works—Bulletin 202 dealing with three types of traps for removing water from compressed air. This 4-page bulletin explains the advantages and limitations of each type of trap and contains specific recommendations on traps for handling water contaminated with heavy oil and sludge, small amounts of clean water from high pressure air lines, and draining receivers, separators, and aftercoolers.

84 LEVER-SEALD VALVES

Homestead Valve Mfg. Co.—Valve Reference Book 39, Section 3 describes the complete line of Homestead Lever-Seald Valves, which require no lubrication. The line includes types for all services from 150 to 1500 pounds pressure. Most types are available in iron, brass, stainless steel and a variety of other metals.

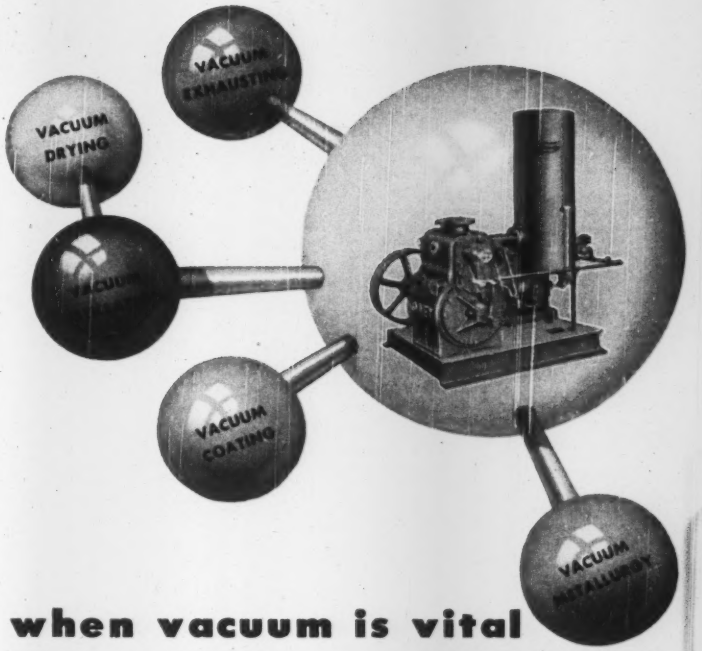
85 SMOKE DENSITY RECORDERS

Bailey Meter Co.—4-page Bulletin explains operation of Bolometer type smoke density recorder. Drawings and photographs illustrate the construction and application of the electronic type smoke recorder, the sealed beam light source, and the sealed beam Bolometer type smoke detector which make up the complete unit for the measurement and recording of smoke densities in ducts and stacks. The Bolometer is described as a modified, sealed beam automobile head lamp which receives all radiation from the light source which is passed by the smoke column. Circuit diagram illustrates method of compensating for voltage variations and ambient temperature changes.

86 HIGH PRESSURE SOLENOID VALVES

Waterman Engineering Co.—4-page Leaflet describes and illustrates new, inexpensive 2-way

Continued on Page 52



when vacuum is vital you can count on KINNEY

Kinney High Vacuum Pumps are at work in all phases of low pressure processing — in the production of television tubes, titanium, penicillin, electrical condensers, coated camera lenses, dehydrated foods, and scores of other products. Their dependability and high pumping speed have helped bring vacuum out of the laboratory and onto the production line. Kinney Pumps are establishing important records both for length of service and economy of operation. They are virtually a "production must" whenever processes require fast pump down to low absolute pressures.

Performance is the big reason why Kinney Pumps are so often specified "when vacuum is vital". Perhaps they can help speed YOUR processes or improve YOUR products. Write for Bulletin V-45, describing the complete line of Single Stage and Compound Vacuum Pumps. Kinney Manufacturing Company, 3582 Washington St., Boston 30, Mass. Representatives in New York, Chicago, Cleveland, Houston, New Orleans, Philadelphia, Los Angeles, San Francisco, Seattle.

Making old things BETTER
Making new things POSSIBLE

FOREIGN REPRESENTATIVES
GENERAL ENGINEERING CO. (RADCLIFFE) LTD. Station Works, Bury Road, Radcliffe, Lancashire, England
HORROCKS, ROXBURGH PTY., LTD., Melbourne, C. I. Australia
W. S. THOMAS & TAYLOR PTY., LTD., Johannesburg, Union of South Africa
NOVELECTRIC, LTD. . . . . Zurich, Switzerland

KINNEY Vacuum Pumps

BUYER'S CATALOG GUIDE

Solenoid Valve for hydraulic systems with operating pressures up to 3000 p.s.i. Compact, for continuous duty, operates on 110 volt, 60 cycle alternating current; impregnated oil and moisture resistant coils, (suitable for oil reservoirs). Mountable in any position poppet construction, full line flow. Available in ¾-inch size.

87 INDICATING, RECORDING AND CONTROLLING INSTRUMENTS

Foxboro Co.—Catalog 370 presents in 16 illustrated pages a brief introduction to the very extensive line of Foxboro Instruments for indicating, recording and controlling industrial process variables. Separate bulletins thoroughly cover individual subjects, including instruments of various types, and instrumentation for specific applications. Correspondence is invited on any phase of instrument engineering involving temperature, pressure, flow, liquid level, humidity, pH, density, conductivity, speed, weight and force, etc., control valves, instrument panels, or complete control systems.

88 GASKETS, PACKINGS AND WASHERS

Melrath Supply & Gasket Co.—Catalog with illustrated description and price listing of Flange Gaskets, Ring Type Gaskets (A.P.I. Rings), Spiral Wound Gaskets (Meltalic), metal and asbestos. Also, corrugated metal and asbestos, French Style and special shape gaskets, and metal stampings.

89 COAL HANDLING EQUIPMENT

Gifford-Wood Co.—24-page Bulletin No. 300 describes the Gifford Wood "4 Basic Types" of coal handling installations, namely, concrete silo, tile silo, cylindrical steel tank and suspended steel bunker. Contains illustrations and working drawings of all four types of installations in many industries. Auxiliary equipment for coal and ash handling is also shown.

90 CONDENSATE DRAINAGE CONTROL

Cochrane Corp.—New 24-page Publication on the Cochrane C-B System of Condensate Drainage Control comprises 6 pages of a technical discussion of this unique system of high pressure, high temperature condensate return, followed by specifications of the two types of C-B unit, after which are detailed fifty-seven case histories and testimonials including photographs, flow diagrams and details of installation, all representing savings in fuel, increased production, more uniform quality and reduction in maintenance and repair costs. A survey form included has provision for sketch as well as details of condensate removal problem.

91 BALL AND ROLLER BEARINGS

Aetna Ball & Roller Bearing Co.—Latest 52-page Catalog gives specifications on Aetna's full line of standard ball thrust bearings, clutch release bearing, ball retainers and hardened and ground washers. Contains helpful technical data for design engineers, useful calculations and formulae, important application principles, fundamentals of proper lubrication, bearing selection and care. Shows the wide variety of special bearings and precision parts falling within the scope of Aetna facilities. Full line includes standard and special ball thrust bearings . . . angular contact ball bearings . . . special roller bearings . . . ball retainers . . . hardened and ground washers . . . sleeves . . . bushings.

92 NEW FORCE-BALANCE TEMPERATURE TRANSMITTERS

Taylor Instrument Cos.—Bulletin 98140 describes new development in temperature transmission—Transaire* Temperature Transmitter with "Speed-Act". Illustrations and diagrams clearly set forth construction, operation and application of instrument. Detailed description of "Speed-Act"—the new derivative action which makes possible Dynamic Accuracy, also includes information on Barometric Compensation, Adjustable Operating Ranges and Small Thermal Elements. *Trademark.

93 PRESSES

American Steel Foundries, Elmes Engineering Div.—12-page Bulletin No. 1010-B covers hydraulic metal working presses. Electric control gives semi-automatic operation, automatic operation, and inching with speed change and reversal of slide governed either by ram travel or pressure, whichever is preferable.

94 CHLORINIZERS

Builders-Providence, Inc.—Bulletin 840-F2. Builders Chlorinizer for feeding chlorine gas has been designed with special attention to insure completely safe and highly accurate operation. Chlorinizers are metering chlorine gas and producing closely controlled concentration of chlorine water solution for process use, and are improving central station operation by controlling slime and mussel growth. A positive and accurate chlorine rate indicator is provided and maintenance due to corrosion is reduced to a minimum because chlorine is controlled and metered in a dry, inert state. The feeder is readily adapted to semi-automatic program or automatic proportional operation and conversion, from one method of operation to any other may be made in the field.

95 IRON CEMENTS

Smooth-On Mfg. Co.—40-page, pocket size Smooth-On Repair Handbook describes practical, time saving, money-saving metal repairs made on plant, shop, factory, garage and home equipment with Smooth-On Iron Cements. Leaks stopped, cracks sealed, loose parts and fixtures tightened. More than a million copies of this popular Manual have already been sent out in response to requests. Contains 170 diagrams. Clear tested directions.

96 STOKERS

Westinghouse Electric Corp.—New Booklet B-4553, "Westinghouse Centrafire with Traveling Grate," describes the newly available Centrafire (Westinghouse principle of spreader firing) with traveling grate for application to boilers with capacity ranging from 30,000 pounds of steam per hour to upwards of 350,000 pounds of steam per hour. Outstanding engineering features, including complete hydraulic drive, oil-governor type fuel-feed control, and automatic control of fuel distribution—the results of seven years' intensive development work—are carefully and thoroughly described. Diagrams and data on actual installations, and convenient tabulation of dimensions and areas, will prove helpful to Central Station and larger industrial users, and boiler manufacturers, interested in this equipment.

97 PIPING AND FITTINGS

Midwest Piping & Supply Co.—"Midwest" Piping Products—Catalog 48, 184 pages of technical information and prices on Welding Fittings, forged steel Flanges and Prefabricated Piping. A convenient handbook for the pressure and process piping industry; contains digests of pipe and fitting specifications, suggestions for piping design and welding, layout data, formulas, etc.

98 BOILER-STOKER COMBINATIONS

Brownell Co.—Bulletin No. SF-1 describes new Unitbilt Boiler-Stoker Combinations. Furnace ironwork of stoker is built-in at factory. After boiler is set, stoker drive assembly is installed by connecting air duct, feed worm, and coal duct. Unitbilts are furnished in 10 sizes with steam radiation of 2190 to 8500 sq. ft.

99 PLATE FABRICATION AND HEAT EXCHANGERS

Downingtown Iron Works, Inc.—Plate Fabrication and Heat Exchanger manufacturers announce the

Continued on Page 54

Make use of this FREE LITERATURE SERVICE

Select desired Catalogs by number, fill in coupon on page 42 and mail promptly.

THE RIGHT ALLOY
is the Right Answer to Many Piping Problems

Until recently, piping engineers were limited in their choice of piping materials to carbon steels, a few low alloy steels, wrought iron, cast iron and brass.

Today, thanks to metallurgical research and new welding techniques—many more materials are available, including intermediate and high alloy steels containing chromium, nickel, or both . . . commercially pure nickel . . . copper . . . aluminum . . . and alloys in which nickel, copper or aluminum is the major constituent.

Rapid corrosion of piping by the fluid handled, or contamination of the fluid by corrosion of the pipe—or by catalytic action of the pipe material with the fluid, are problems which today's piping engineer faces. Often, these problems are complicated by pressures and temperatures at which the fluid must be conveyed, or by wide fluctuations of pressures and temperatures when the process is cyclic in nature.

Each of these service conditions demands utmost care in the selection of the piping material.

Tube Turns, Inc. is constantly studying all of the factors involved in the application of alloy materials to piping systems. Today the ever-expanding line of Tube-Turn Welding Fittings includes more than 40 different alloys in both ferrous and non-ferrous classes . . . to help solve *your* piping problems.

FREE BULLETIN

Write today for your free copy of "Special Alloys", a bulletin containing valuable information of Stainless Steels, Nickel and Nickel Base Alloys, Copper and Copper Base Alloys, and Aluminum and Aluminum Base Alloys. Discusses physical characteristics, service conditions and gives chart of sizes and wall thicknesses available.

"Be Sure You See The Double tt"

TUBE TURNS, INC.

LOUISVILLE 1, KENTUCKY

In all the world there's only one TUBE-TURN Welding Fitting as shown by this trade mark... the right mark for every need in welding fittings and flanges.

TUBE-TURN

Your nearby TUBE TURNS distributor can serve you right from stock. Call him for prompt delivery.

TUBE TURNS, INC., LOUISVILLE 1, KENTUCKY DISTRIBUTORS IN ALL PRINCIPAL CITIES

DISTRICT OFFICES: NEW YORK • PHILADELPHIA • PITTSBURGH • CHICAGO • HOUSTON • TULSA • SAN FRANCISCO • LOS ANGELES

All These Were Once

DUST COLLECTION PROBLEMS, TOO

48 Carbon Black Plants
203 Metallurgical Installations
205 Acid Plants • 40 Paper Mills
270 Delarring Installations
216 Power Stations
73 Steel Plants • 99 Oil Refineries
and Miscellaneous Installations

Your electrical precipitator installation will be individually engineered...and based on the Research Corporation's *experience* graphically shown by that towering pile of thousands of blue prints.

This knowledge is a valuable asset that will help Research engineers to "tailor-make" your Cottrell installation. For example, they can more quickly determine the right answers to such variables as the size, shape and type of both discharge and collecting electrodes, their relative spacing, flue arrangements and many other factors. At Research you can count on *profitable solutions to individual problems.*

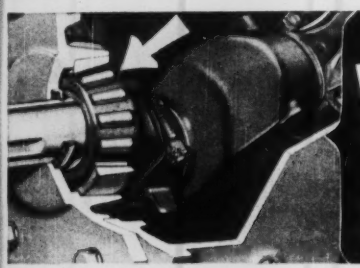
Research Corporation Cottrells can be made as efficient as you desire. They can collect 95% to over 99% of all solid or liquid particles suspended in gas entering equipment. Write for free booklet giving valuable data. RC-121

Typical One Day Collections

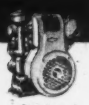
• 250 TONS OF FLY ASH
• 5500 POUNDS OF CONCENTRATED SULPHURIC ACID
• 6 TONS OF SODA SALTS AT PAPER MILL

RESEARCH CORPORATION

405 Lexington Ave., N. Y. 17, N. Y. 122 S. Michigan Ave. Chicago 3, Ill.



Why
WISCONSIN
HEAVY-DUTY *Air-Cooled* **ENGINES**
Run on Timken Tapered Roller Bearings



Single cyl. 3 to 9 hp.

2-cylinder 7 to13 hp.

V-type 4-cyl. 15-to 30 hp.

Ever since the first Wisconsin Air-Cooled Engine was built over 20 years ago, the crankshaft of every one of these fine engines has been supported by Tapered Roller Bearings at BOTH ENDS. Here's why:

1. Tapered Roller Bearings take up all *End Thrusts* and *Radial Loads* (impossible with other types of bearings). You can mount your drive directly on the extended crankshaft of any Wisconsin Engine without the need for an extra thrust bearing or outboard bearing.

2. Tapered Roller Bearings resist wear to a greater extent than other types of bearings not only because of the file-hard surfaces of Timken Tapered Bearings but also because these bearings are inherently SELF-CLEANING. Oil enters at the smaller end of tapered roller bearings and centrifugal force carries it out through the large end, thus preventing accumulations of dirt and sludge that is often present in the oil. (Tapered bearings cannot develop shaft-cutting abrasive surfaces.

3. Tapered Roller Bearings permit flexing of the crankshaft to a much greater degree than the longer, rigid plain bearings which cannot stand up under flexing conditions, resulting in wearing "bell-mouthed" or failing completely. We have yet to hear of a single case of Wisconsin Engine bearing failure.

The use of dependable Tapered Roller Bearings in ALL Wisconsin Engines from the smallest to the largest . . . 3 to 30 hp., single cylinder, 2-cylinder and 4-cylinder . . . is typical of the engineering diligence devoted to providing the user with "Most H.P. Hours of on-the-job service".

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 14, WISCONSIN

CATALOG GUIDE

availability of their latest Plate Fabrication and Heat Exchanger Bulletin. This attractive 16-page bulletin contains lists of general facilities, manufacturing equipment, welding procedure qualifications, and standard Heat Exchanger construction details. It also has sections devoted to typical Plate Fabrication and Heat Exchanger examples, with story and illustrations of plant and manufacturing equipment.

100 FITTINGS AND CARRIERS FOR WALL FIXTURES

J. A. Zurn Mfg. Co.—Catalog No. 50 presents comprehensive data on Fittings and Carriers for supporting Wall Fixtures of all types. Interesting data on new sanitation standards for public and private toilet rooms, including industrial, municipal and all types of construction. Standards accepted by all plumbing fixture manufacturers.

101 STRAIN ANALYZERS

Brush Development Co.—Two Bulletins available giving basic information on strain gage circuits and the calculation of simple stresses using wire resistance strain gages. Also many engineers will be interested in a specification sheet F-376 giving details on the Brush Direct Recording "Strain Analyzer."

102 VALVES

R-S Products Corp.—A 10-page Catalog (18) introduces a line of 50-lb., narrow face-to-face valves designed for rugged hydraulic service. The various types of valves and controls are described and illustrated. Also illustrated are the stuffing boxes, which include plain, lubricated, lubricated with purge connections and the rotary seal. A description of the rubber seat, a list of special metals used for unusual requirements, plus valve dimensions and weights are included.

103 SURFACE ROUGHNESS MEASUREMENT

Physicists Research Co.—Looseleaf Catalog of Profilometer equipment for measuring the roughness of practically all machined, ground and finished surfaces in definite microinch units. Includes information on shop applications of the Profilometer for quality control and production economy, plus separate illustrated descriptive pages with complete specifications on each item of equipment.

104 DRIVES FOR COMPRESSORS, FANS AND PUMPS

J. E. Rhoads & Sons—New Handbook recently prepared on Short Center Drives for compressors, fans and pumps. This handbook describes the short center drive and tells how it operates and why it is ideal for driving compressors, fans and pumps.

105 SLIP CLUTCHES AND COUPLINGS

Hilliard Corp.—Completely new Literature describing the expanded line of Hilliard Slip Clutches and Couplings is now available. These new bulletins include technical data, selection tables, prices, examples for applying the units to applications for overload protection, reeling and winding operations, as well as a section devoted to a new clutch that is capable of adjusted torque setting while in operation.

106 CONE-DRIVE SPEED REDUCERS

Cone-Drive Gears Div. of Michigan Tool Co.—4-page Bulletin showing standard speed reducers with standard air-flow control shields and fans for fan-cooling. When thus equipped, thermal ratings can be ignored and reducers selected on basis of mechanical rating only. Fan-cooled Cone-Drive reducers, it is claimed, represent the lowest cost per horsepower transmitted of any type of reducer due to the compactness made possible by the double enveloping gearing.

107 TECHNICAL BOOKS

The American Society of Mechanical Engineers—1951 Catalog of A.S.M.E. Publications. A 20-page descriptive price list of current books, standards, codes, research reports, and periodicals published by the Society.

108 STEAM TURBINES

DeLaval Steam Turbine Co.—DeLaval Catalog 4215 describes the very first "Standard" single stage turbine for "High Pressure" service. This turbine is suited for mechanical drive and turbine generators. Catalog shows design and construction features and illustrates eight different governor systems.

109 BRONZE CASTING ALLOYS

American Manganese Bronze Co.—50-page edition of the "Reference Book on Bronze Casting Alloys." In it is given general information regarding com-

CATALOG GUIDE

position, characteristics and applications of many of the common or typical alloys. The Book will help the engineer or designer in the selection of the right alloys for any general application.

110 WATER TUBE BOILERS

Henry Vogt Machine Co.—20-page Bulletin describing the Class VL, 3-drum bent tube boiler. Photos and line drawings with design data, illustrates typical units as installed in various industries.

111 FLEXIBLE COUPLINGS

Lovejoy Flexible Coupling Co.—Illustrated Catalog with Selector Charts. Grouping and application of L-R Flexible Couplings. Describes and pictures various types of couplings, with cutaway views and diagrams. New couplings for D-C standard mill motors. Selector Charts make it easy to choose correct type and size of coupling with proper cushion material for application.

112 SELF-LUBRICATING BUSHINGS

Graphite Metallizing Corp.—Booklet "Graphalloy Bushings" illustrates the use of "Graphalloy" bushings which operate without oil. Application data given for use at temperatures where oil solidifies and volatilizes, for bushings submerged in water, gasoline, weak acids. Also for high speed operation, dry or in liquids or where lubricants might fail.

113 SPEED MEASURING INSTRUMENTS

James G. Biddle Co.—The description, operation and selection of the Biddle line of chronometric, centrifugal and resonant reed tachometers are presented in the new 28-page Bulletin 35-50. A variety of integrating and direct-indicating instruments, together with such variations as the Tachonorm, Tachograph, Tachoscope and many adoptions of the "Frahm" resonant reed principle, are also described. A wide selection of ranges up to 100,000 rpm are available in single and multi-range instruments.

114 STOKERS

Westinghouse Electric Corp.—New Booklet B-3890-A, "Westinghouse Centrafire, with the famous Link-Grate," presents the unique Centrafire principle of firing which distinguishes this unit from the ordinary type of spreader stoker. The "Gas producer" process, causing low-velocity monoxide gases with low-particle carrying capacity to rise above the central fire zone, and subsequent admixture of metered overfire air to convert monoxides to carbon dioxide is thoroughly discussed and explained. Action of the Westinghouse Link-Grate, to keep the fuel bed mobile and porous and provide an intimate mixing with under-grate air, is likewise described. Construction, operation, automatic synchronous operation from single-source hydraulic drive, application to various boiler types, and Westinghouse consultation and field service facilities are presented in detail.

115 TECHNICAL BOOKS

John Wiley & Sons—Publishers of scientific and technical books. 1950 Catalog available, containing descriptions of over 1300 books in science and engineering. Of particular interest to engineers are the following recently published Wiley titles: Pender's "Electrical Engineers' Handbook," fourth edition—Pender and Del Mar's "Electric Power"; Jakob's "Heat Transfer," Volume I; Hudson's "Conveyors and Related Equipment"; Koepke's "Plant Production Control"; Sutton's "Rocket Propulsion Elements."

116 BLAST CLEANING AND DUST CONTROL

Pangborn Corp.—The latest developments in blast cleaning or dust control in Bulletin 1200, "Pangborn's" Condensed Catalog. This complete bulletin is colorful, interesting, full of pictures and drawings to tell the full story of air and airless blast cleaning, hydro-sand blast, wet sand blast, accessories and dust control.

117 OIL SEALS

Johns-Manville—Clipper Seal Brochure describes complete story of this precision moulded oil seal that provides efficient bearing protection at low cost. Includes photographs and diagrams of typical installations; shows how various lip designs provide choice of bearing surfaces; how its simple one-piece construction allows greater freedom in designing oil seal cavities.

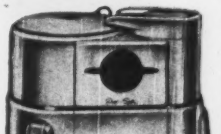
118 STAINLESS STEEL PUMPS

Goulds Pumps, Inc.—Complete descriptive Bulletin No. 725.3 on new line of stainless steel centrifugal pumps for the chemical process and other industries. Pumps are single stage semi open impeller centrifugal type built in 8 sizes, capacity range up to 720 GPM with heads up to 200 ft. depending on ca-

Continued on Page 56

THIS LUBRICANT SAVES GEARS AND TRANSMISSIONS

—says AUTOMATIC WASHER COMPANY Newton, Iowa



They write us.

"We have used LUBRIPLATE in our washing machine transmissions since 1933. Our laboratory tests as well as field experience indicate that through the use of LUBRIPLATE we reduced the wear on the gears and prolonged the life of the transmission.

"The transmission is the heart of any washing machine, and the long life and trouble-free performance obtained by the use of LUBRIPLATE in the Automatic Washer transmission has been an important factor in the success of our product."

AUTOMATIC WASHER COMPANY
F. Breckenridge
Executive Vice-President

The use of LUBRIPLATE in a washing machine is a severe test. Bearings and parts are subjected to moisture, hot water, caustics and sometimes acids. A lubricant to give efficient lubrication under these conditions must be an unusual product.

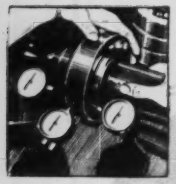
LUBRIPLATE Lubricants reduce friction and wear, prevent rust and corrosion, save power. Because LUBRIPLATE Lubricants last longer, they are more economical to use.

Let us send you CASE HISTORIES of the use of LUBRIPLATE Lubricants in your industry. There is a LUBRIPLATE product best for every lubrication need. They range from the lightest fluids to the heaviest greases. They are different from any other lubricants you have ever used. Write today for further information.

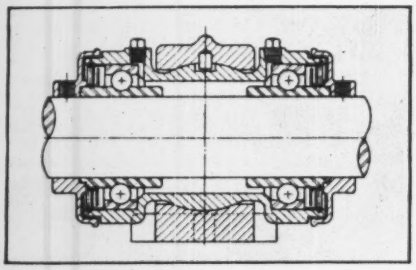
LUBRIPLATE DIVISION
Fiske Brothers Refining Company
Newark 5, N. J. Toledo 5, Ohio

DEALERS EVERYWHERE . . . CONSULT YOUR CLASSIFIED TELEPHONE BOOK

THE MODERN LUBRICANT



with BALL BEARINGS
— the small extra first cost of test samples pays off in assurance of efficiency and durability of the finished mechanism.



with TRACING CLOTH . . .

The small extra first cost of Arkwright Tracing Cloth, over that of tracing paper, repays many times over in the efficiency and durability of valuable drawings.

Through continued research and development plus skilled manufacturing processes, Arkwright Tracing Cloths meet every requirement of exacting draftsmanship. You'll find no pinholes, stains or other imperfections to detract from drawing quality — nor smudging or feathering after repeated erasures. Most of all, you'll have highly transparent, long lasting usefulness that perishable tracing paper can never match.

For every drawing worth keeping for future use — specify permanent Arkwright Tracing Cloth. Send now for generous working samples. Sold by leading drawing material dealers everywhere. Arkwright Finishing Company, Providence, R. I.

The Big Six Reasons Why Arkwright Tracing Cloths Excel

1. Erasures re-ink without feathering
2. Prints are always sharp and clean
3. Tracings never discolor or go brittle
4. No surface oils, soaps or waxes to dry out
5. No pinholes or thick threads
6. Mechanical processing creates permanent transparency

ARKWRIGHT
TRACING CLOTHS
AMERICA'S STANDARD FOR OVER 25 YEARS

CATALOG GUIDE

pacity. Highly corrosion resistant for acids, alkalies, slurries, etc.

119 VIBRATION CONTROL

MB Mfg. Co.—Products for the detection, reproduction and isolation of vibration are described in Bulletin 410. Booklet contains helpful design data on vibration control, plus information on Isomode pad, Isomode units and details on MB Vibration Exciters and Test Equipment.

120 MINIATURE BALL BEARINGS

New Hampshire Ball Bearings, Inc.—Technical Bulletin No. 50 lists a full line of groun dminiature bearings, including the only miniature Conrad (retainer) bearings manufactured in the U. S.

121 SPEED REDUCERS

W. A. Jones Foundry & Machine Co.—Bulletin No. 68 covers the latest information on Jones Worm Gear Speed Reducers. Heavy duty machines are furnished in type "H" with worm below gear and in type "R" with worm above gear. They have horsepower ratings in accordance with the recommended practice of the American Gear Manufacturers Association.

122 WATER JET EDUCTORS

Schutte & Koerting Co.—New 35-page Bulletin 2-M contains full information on design, construction and operation of many types SK Water Jet Eductors for the pumping and/or mixing of liquids and the handling of solids. Various types for various applications are clearly defined and illustrated.

123 SEAMLESS STEEL TUBING

Timken Roller Bearing Co.—52-page illustrated Handbook of seamless steel tubing is valuable to all Mechanical Engineers. It describes how seamless steel tubing is made, the advantages, available sizes and finishes; theoretical foot weights for a wide range of sizes; tubing tolerances, plus the method of calculating the right tube size to buy.

124 FLUID POWER EQUIPMENT

Oilgear Co.—New 8-page Bulletin 10051 illustrating and describing their complete line of Fluid Power Pumps, Motors, Transmissions, Cylinders and Valves. It features a new line of small constant and variable delivery pumps . . . a new line of axial piston motors . . . an improved line of standard cylinders for pressures up to 1500 psi and a new line of heavy-duty cylinders for pressures up to 3000 psi. It introduces their standard line of pilot and directional control valves, relief and foot valves, surge (pre-fill) valves, combination valves, differential valves and auxiliary fluid equipment for pressures up to 3000 psi.

125 PUMPS

Aurora Pump Co.—Condensed Catalog M, embodying illustrations, suggested uses, specifications, and condensed selection tables for Aurora Centrifugal and Apco Turbine Type Pumps and Water Systems.

126 AIR-COOLED ENGINES

Wisconsin Motor Corp.—56-page delux Catalog, printed 2 colors, illustrating and describing factory production processes of engines in detail, with 146 illustrations and captions covering a great variety of engine power applications in many fields, illustrations of full line of engines, 2 to 30 hp, with brief specifications, general data, and list of Wisconsin distributors by states.

127 MULTITHERM UNITS

Clarage Fan Co.—Bulletin No. 107, Clarage Multitherm Unit for vital industrial air conditioning services. Types to furnish cooling only, heating only, or year-round control of temperature and humidity quickly installed—no building alterations or elaborate duct system required. Used to speed production. Large range of sizes.

128 DUST COLLECTORS

Prat-Daniel Corp.—Prat-Daniel Tubular Dust Collectors—Valmont Type "S" and Standard Type H-C. This Bulletin describes new developments in tube design that increase efficiency through improvement of the size and shape of the inlet aperture so as to admit incoming gases in the shape of a deep, narrow ribbon. This reduces the distance the dust particles travel before coming in contact with the precipitating wall, and results in great collection efficiency. Bulletin also contains details for using mechanical collectors in series with electrostatic. Bulletin No. 250-S.

129 DOUBLE-SUCTION PUMPS

Economy Pumps, Inc.—Horizontal, single stage, double suction pumps for general water supply and booster service; brine or hot water circulation;

CATALOG GUIDE

condenser injection; hot well or makeup water service; white water and overflow in paper mills are described in new Bulletin No. A-1147 Cm. Construction details and selection tables are included.

130 WATER SOFTENERS

Permutit Co.—Bulletin 2997 describes the application of the Sludge Blanket Design to hot process method of softening water, and explains the advantages. (1) Delivers soft water. (2) 50% more silica removed than with previous types of equipment. (3) Eases load on filters. (4) Substantial savings in chemicals.

131 FRACTIONAL HORSEPOWER GEARS

Gear Specialties—4-page Catalog Bulletin illustrating and describing many different types and applications of G.S. Small Gears. Illustrating many applications entirely without precedent; new principles, new design, new engineering. Gears from 12 to 96 D.P.

132 STEAM BOILERS

Wickes Boiler Co.—Bulletins No. 44-1, 2, 3, 4, 46-2, 48-1, 48-2, and 49-1 describing water tube boilers of the 2-, 3-, and 4-drum design for direct firing by means of oil, pulverized coal or stokers; also waste heat units, Dowtherm, and package-type water tube boilers, Dowtherm Vaporizers, and Steam Generators. Boilers are built for pressures up to 850 p.s.i. and capacities to 250,000 lbs. of steam per hour.

133 FLEXIBLE SHAFTING

F. W. Stewart Mfg. Corp.—Have just issued a Bulletin "Flexible Shaft Assemblies," on their new Power Drive Circle Ess Flexible Shafting. Greater opportunity for diversified stream-lined power transmission is offered for use in all types of metal, plastics, porcelain or wood work. They can be applied in hundreds of finished operations, in fact wherever constant power in a portable tool is required. Three types of Power Drive Flexible Shafts are presented—for heavy, medium and light duty in commercial or industrial work—also a high speed light weight Flexible Shaft Kit is offered to meet the demand for a wide range and quick change of speed.

134 TUBING

Bundy Tubing Co.—New 20-page Booklet in colors. Contains technical data and fabricating information on Bundyweld steel (copper or tin coated) tubing of particular interest to production and design engineers in metal-working industries.

135 HYDRAULIC ELECTRIC POWER UNITS

American Blower Corp.—New Gyrol Fluid Drive Hydraulic Electric Power Units. "Power in a Package" pictorially described in Bulletin No. 8519. Bulletin mentions applications, shows illustrative test photographs, and includes ratings and dimensions.

136 THERMOSTATS

Fenwal, Inc.—Catalog on unique Thermoswitch* Heat Control, a precision thermostat having outstanding advantages of instant response, high accuracy, wide range, rugged construction and ease of installation. Temperature-sensitive element is external metal shell which actuates and protects internal contacts. Catalog describes wide application and gives full engineering details, and shows how Thermoswitch unit can often replace expensive control instruments. (*Reg. U. S. Pat. Off.)

137 CORRECTING WATER PROBLEMS

D. W. Haering & Co.—A number of valuable and interesting Pamphlets on scale and corrosion correction in industrial plants have been prepared by this company. For instance "Cooling Water," "Organic Methods of Scale and Corrosion," "Cooling System Problems," and several other bulletins that are very helpful in correcting Water Problems in industrial plants.

138 DROP FORGINGS

Drop Forging Association—Revised edition "Metal Quality—Hot Working Improves the Properties of Metal." This new 64-page Booklet issued by the Technical Committee of the Drop Forging Association for users of forgings—design engineers, metallurgists and production and management executives. The booklet describes and illustrates the development of metal quality progressively throughout hot working operations, from the blast furnace to the finished forging. A discussion is presented of forging quality steel and the proper selection of metals for forgings. Steps in making forging dies and the various methods of hot working metal by forging are reviewed. Forging procedures of various kinds of parts are outlined such as parts with thin sections, projections holes, etc. Economic advantages of forgings are highlighted.

Continued on Page 58

Preferred

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES

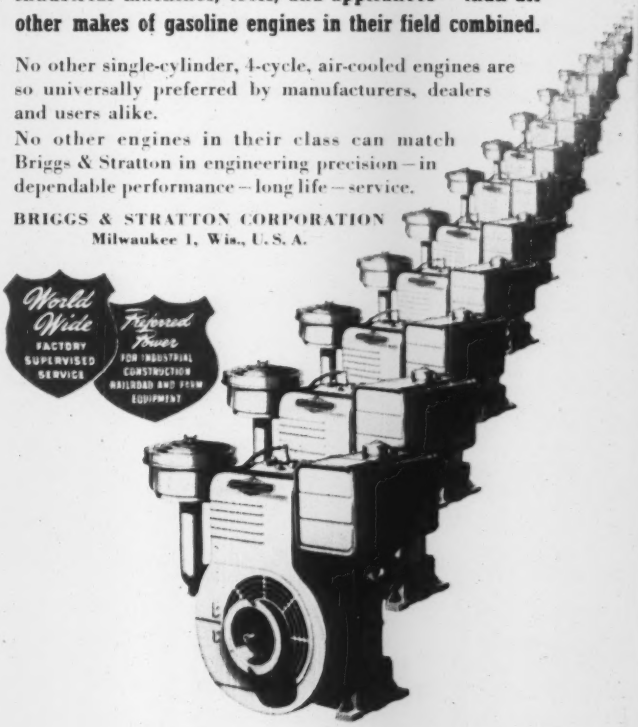
air-cooled **POWER**

. . . . There are more Briggs & Stratton air-cooled gasoline engines in service — on farm equipment, industrial machines, tools, and appliances — than all other makes of gasoline engines in their field combined.

No other single-cylinder, 4-cycle, air-cooled engines are so universally preferred by manufacturers, dealers and users alike.

No other engines in their class can match Briggs & Stratton in engineering precision — in dependable performance — long life — service.

BRIGGS & STRATTON CORPORATION
Milwaukee 1, Wis., U. S. A.



WE ARE
PROUD
AND
CONFIDENT
OF
EVERY
FABRICATION . . .

WHICH MEANS MONEY
SAVED FOR YOU!

One of two tanks on the order 102" I.D. x 28' 1¾" high overall . . . fabricated by DOWNINGTOWN in accordance with ASME Code, Par. U-68 for 400# working pressure. Shells are 1 9/16" thick of SA-212 Firebox, Grade "B" Steel . . . heads are ASME Code, Elliptical, 1½" minimum thickness of SA-212 Firebox, Grade "B" Steel. Tanks hydrostatically tested at 600#, hammer tested, then subjected to an 800# hydrostatic test. Tanks stress relieved after fabrication by heating 1100° to 1200° F., and held at that temperature at least 1 hour per inch of thickness . . . finally, sandblasted inside and outside previous to painting.

DOWNINGTOWN Engineers and Technicians have given considerable study to many factors and processes of Plate Fabrication. Consequently, we have arrived at conclusions which we firmly believe assure a quality job.

Your inquiries for pressure vessels of Nickel Clad, Stainless, Stainless Clad, Carbon Steel, are solicited. Another important factor of our business is the design and fabrication of Heat Exchanger Equipment.

NEW YORK OFFICE: 30 CHURCH STREET

DOWNINGTOWN IRON WORKS
DOWNINGTOWN, PA.
WELDED and RIVETED PRODUCTS

MERCURIAL BAROMETER

Built for Long Service

- DEPENDABLE
- ACCURATE

The low cost barometer that gives accurate readings and years of dependable service is available again. No. 76890 Cenco Mercurial Barometer is well known in thousands of laboratories throughout the world for accuracy and long life.

No. 76890 Cenco Mercurial Barometer — with scales ranging from 600 to 800 mm and 24.5 to 31.5 inches — verniers for reading to 0.1 mm or 0.005 inch . . . . . Each $34.00

No. 76891 Cenco Mercurial Barometer, for altitudes from 1,500 up to 10,000 feet. . . . . Each $41.00

CENTRAL SCIENTIFIC COMPANY
Scientific CENCO *Apparatus*
1700 IRVING PARK ROAD CHICAGO 13
NEW YORK BOSTON SAN FRANCISCO NEWARK LOS ANGELES TORONTO MONTREAL

CATALOG GUIDE

139 MACHINE DESIGN SHEETS

Lincoln Electric Co.—A series of single-page Sheets, punched for notebook filing, giving the fundamentals through concrete illustration of the correct approach to welded design. Current series tells how to design for welding the basic elements of machinery, such as wheels, levers, brackets, bases, containers and covers.

140 BLOWERS, EXHAUSTERS, PUMPS, ETC.

Roots-Connersville Blower Corp.—Regularly issues individual Bulletins covering Centrifugal Blowers and Exhausters; Rotary Positive Blowers, Gas Pumps, Liquid and Vacuum Pumps; Positive Displacement Meters, and Inert Gas Generators.

141 NEW DI-ACRO POWER SHEARS AND BENDERS

O'Neil-Irwin Mfg. Co.—Two entirely new power driven machines have recently been added to the "Di-Acro Line" of Die-Less Duplicating Equipment. These are a precision variable speed Power Shear and a Hydraulic Production Bender which will form all types of ductile materials including tubing, angle, channel and extrusions. The Di-Acro 40-page catalog, No. 49-15, contains complete information covering these new products as well as all hand operated Di-Acro Benders, Brakes, Shears, Notchers, Punches and Rod Parters which are offered in a total of eighteen sizes.

142 STRAIN MEASUREMENT

Hathaway Instrument Co.—4-page Catalog Leaflet entitled "Dynamic Strain Analysis—General Considerations" outlines the elements necessary for a complete dynamic strain analysis laboratory and describes briefly strain gages, five types of strain gage amplifiers for dynamic work, and eight types of oscillographs suitable for recording 6 to 24 records simultaneously and covering a frequency response range from zero or static to 50,000 cycles per second. Hico 3.00-1.

143 FOAM RUBBER, SPONGE RUBBER

Sponge Rubber Products Co.—New 4-page Folder illustrates shapes and forms, into which cellular rubber can be molded or die cut, tubing, cord, strips, sheets, rolls, pads. Describes typical applications in upholstering, sealing, insulating, gasketing, dust proofing, weather stripping, sound deadening, shock absorption. Offers experimental examples.

144 GEARMOTORS

Foote Bros. Gear & Machine Corp.—Engineering Manual GMA fully describes the new Foote Bros.-Louis Allis Gearmotors and contains complete application and selection information and dimensions. These gearmotors employ hard helical gears and other moving parts, specially processed and heat treated by new methods. Single, double and triple reduction units provide output speeds from 780 down to 7.5 RPM. Horsepower ratings from 1 through 75 hp. AC and DC motors of all types are available including those with special electrical characteristics.

145 GEARED-HEAD LATHES

American Steel Foundries, King Machine Tool Div.—2-color Catalogs illustrating and describing Sebastian Standard Type "R" Lathes (Catalog S-1) and Sebastian Special Type "R" Lathes —Gap, Clutch, and Brake, etc. (Catalog S-101). Both catalogs include complete specifications.

146 AUTOMATIC CONTROLS

General Controls Co.—Recently announced the release of two new Catalogs. No. 53G, a 100-page publication, covers the complete line and is profusely illustrated, as well as containing informational tables on the various control items. Another publication, No. 53H, covers the heating control products only, although the format is similar to the larger issue.

147 SHAFT SEALS

Peerless Pump Div., Food Machinery & Chemical Corp.—Mechanical shaft seals, available in 3 types, standard, abrasive-resistant and special, and their application to sealing off various liquids around rotative shafts are described in Bulletin B-571. Seals replace conventional packing and will handle up to 400 psi and temperatures to 250° F.

148 VENTILATING AND EXHAUST FANS

Chelsea Fan & Blower Co.—Chelsea's complete new Catalog covering a full range of ventilating and exhaust fans for use in industrial, commercial and residential applications. This includes full engineering data and dimensions of all equipment as well as applications for the use of all this equipment. Complete new brochure for ready reference.

CATALOG GUIDE

149 MATERIALS HANDLING GUIDES

Lewis-Shepard Products Inc.—Offer three new Bulletins: No. 24, The "Jacklift" Power Truck and The "JackStacker," both for use with skids and single and double faced pallets. No. 25, "Space-Master" Electric Fork Trucks. No. 26, Hydraulic and Mechanical Hand Lift Trucks, and "Weld-Master" Skid Platforms.

150 DIAPHRAGM VALVES

Grinnell Co.—Catalog 4-S illustrating and describing both hand operated and remote control pneumatic or hydraulic operated Grinnell-Saunders Diaphragm valves. Used where freedom from contamination, low pressure drop, chemically inert linings and diaphragms, minimum maintenance and drop-tight shut off are required. Complete specifications given, applications illustrated.

151 REPRODUCTION MATERIALS FOR ENGINEERING

Eastman Kodak Co.—A line of photographic materials for engineering drawing reproduction is described in a new booklet, "Modern Drawing and Document Reproduction with Kodagraph Reproduction Materials." Of particular interest to engineers are three direct-to-positive printing, room-light-handling materials . . . Kodagraph Autopositive Paper, Kodagraph Autopositive Film, and Kodagraph Autopositive Cloth, which have valuable applications for making intermediates. They can be exposed with conventional drafting room equipment. Also described are Kodagraph Contact Paper and Kodagraph Projection Papers, as well as Kodagraph Contact and Projection Cloths, which meet additional requirements of drafting rooms and reproduction departments.

152 VERTICAL BORING AND TURNING MACHINES

American Steel Foundries, King Machine Tool Div.—New 2-color Catalogs, fully illustrated containing complete description and specifications on "King" Vertical Boring and Turning Machines. Catalog K-1 covers machines sizes 30", 36", 42"; Catalog K-2, sizes 52", 62", 72". Catalog K-3, sizes 84", 100". Catalog K-4, sizes 120", 144".

153 DIRECT FIRED AIR HEATERS

Peabody Engineering Corp.—What is probably the first, and certainly the most detailed, Direct Fired Air Heater Bulletin ever printed has just been made available. Printed in four colors, the 6-page bulletin (Peabody Bulletin No. 600) is illustrated with flow charts in full color, cross-section drawings, typical applications and operating data that not only simplifies the definition and understanding of Direct Fired Air Heaters but clarifies their applications as well.

154 FELTS

American Felt Co.—Has available a special S.A.E. Folder containing technical data and specifications of the various felts made to S.A.E. standards. The folder includes illustrative samples.

155 PNEUMATIC TRANSMITTERS

Republic Flow Meters Co.—Data Book 1000, 28 pages. Republic Pneumatic Transmitters are devices for converting process variables such as flow, pressure, level, and density measurements into proportionate air pressures which in turn can be used for purposes of readings, regulation and control. Operates on forced balance principle. Bulletin profusely illustrates and explains operating principles and applications. Contains complete specifications and application diagrams.

156 INSULATED PIPING

Ric-Wil Co.—Four Catalogs, 480-2, 480-4, 480-4A, 480-5, available, giving full technical data and illustrations on the design, engineering and installation of Ric-Wil Prefabricated Hel-cor Foil-clad, and Sectional Tile or Cast Iron Insulated Piping Systems. Books include all specifications, engineering and performance data necessary to intelligent planning or designing of efficient Piping Systems, for underground or overhead distribution of steam, hot water, oil, or other process liquids and gases.

157 RECORDING OSCILLOGRAPHS

Consolidated Engineering Corp.—A new 16-page Bulletin just issued. This publication discusses the applications, operations, and features of these well-known multichannel recording oscillographs. Sample records of actual applications are presented along with detailed assembly drawings. A section, complete with technical information and response curves, is devoted to Consolidated Galvanometers. The balance of the catalog presents accessories, associated equipment, and the Customer Service Plan.

Continued on Page 60

it's NEW!

A COMPLETE BULLETIN IN COLOR . . . ON

PEABODY

DIRECT FIRED AIR HEATERS

with application data on pressure fired systems

Any drying problems? Spray, tunnel, or rotary kiln? Or even compartment and cabinet drying and annealing? Does your process involve odor elimination, stress relieving, concentration or evaporation of liquids, drying coal, ore and other solids, gas turbine drive or refinery catalytic cracking—in fact *any* preheating of air? If it does, it will pay you to write for Peabody's new six-page, four-color Direct Fired Air Heater Bulletin 600. Complete with operating data, typical diagrams and a cross-sectioned air heater, this Bulletin 600 may well have the answer to vital problems that affect both your profit and your production.

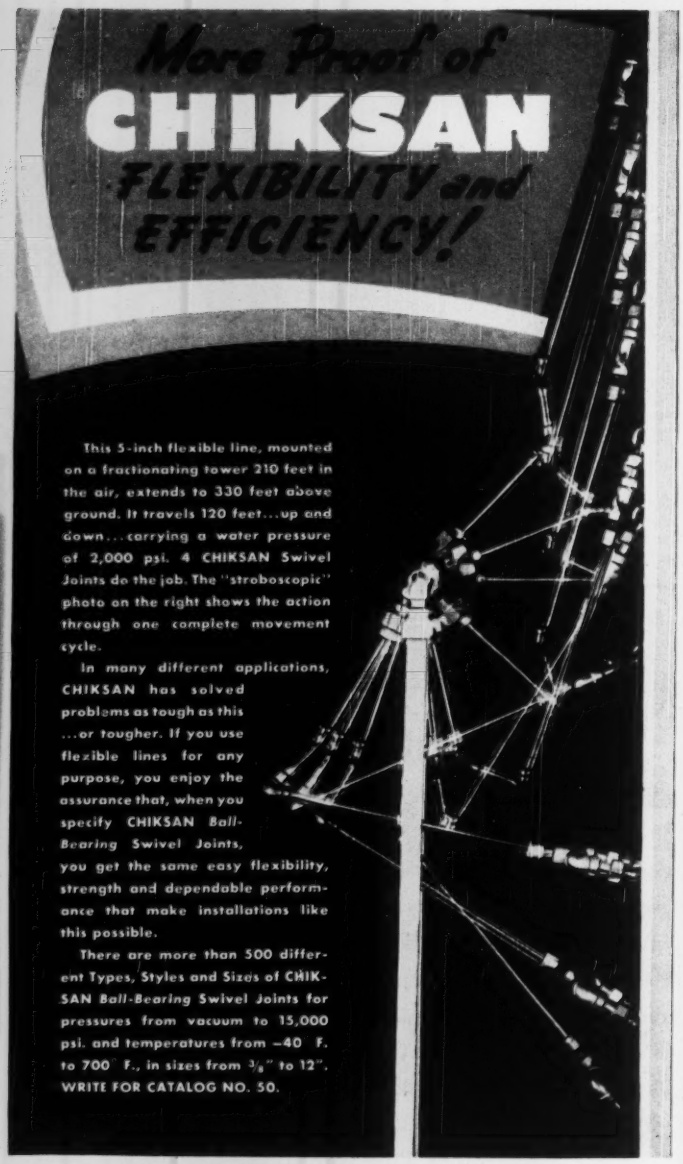
Write today, no obligation.

524

OFFICES IN PRINCIPAL CITIES

PEABODY
ENGINEERING CORPORATION
580 FIFTH AVENUE • NEW YORK 19, N.Y.
Manufacturers of combustion equipment, direct fired air heaters, gas scrubbers, coolers, and absorbers

PEABODY LIMITED • LONDON, S.W. 15, ENGLAND


More Proof of
CHIKSAN
FLEXIBILITY and
EFFICIENCY!
This 5-inch flexible line, mounted on a fractionating tower 210 feet in the air, extends to 330 feet above ground. It travels 120 feet...up and down...carrying a water pressure of 2,000 psi. 4 CHIKSAN Swivel Joints do the job. The "stroboscopic" photo on the right shows the action through one complete movement cycle.
In many different applications, CHIKSAN has solved problems as tough as this ...or tougher. If you use flexible lines for any purpose, you enjoy the assurance that, when you specify CHIKSAN Ball-Bearing Swivel Joints, you get the same easy flexibility, strength and dependable performance that make installations like this possible.
There are more than 500 different Types, Styles and Sizes of CHIKSAN Ball-Bearing Swivel Joints for pressures from vacuum to 15,000 psi. and temperatures from −40° F. to 700° F., in sizes from 3/8" to 12". WRITE FOR CATALOG NO. 50.

The location of this flexible line, at the top of the fractionating tower, demands dependable performance with minimum maintenance attention. CHIKSAN Ball-Bearing Swivel Joints meet these requirements fully.

REPRESENTATIVES IN PRINCIPAL CITIES
SOLD BY LEADING SUPPLY STORES EVERYWHERE

CHIKSAN
TRADE MARK REG.

CHIKSAN COMPANY
AND SUBSIDIARY COMPANIES
Chicago 3 · BREA, CALIFORNIA · New York 7
WELL EQUIPMENT MFG CORP. HOUSTON 1, TEXAS
CHIKSAN EXPORT CO. BREA, CALIFORNIA - NEW YORK 7

BALL-BEARING SWIVEL JOINTS FOR ALL PURPOSES

CATALOG GUIDE

158 IMPROVING METALS BY FORGING

Steel Improvement & Forge Co.—44-page informative Catalog on shaping and improving metals by forging. Shows pictures of methods used, including designing, die sinking, drop forging, heat treating, and inspection for quality control. Contains tables of the characteristics and applications of commercial forging metals, and standard tolerances for drop forgings.

159 ELECTRIC HEATING

Martin-Quaid Co., Hynes Electric Heating & Process Div.—Catalog 101 deals with the Hynes patented system of the Electric Heating of circulating oils and other fluids. Contains curves on flow to temperature rise, piping layouts and complete description of heat transfer systems. Also includes other Martin-Quaid facilities for design and manufacture of complete processing equipment.

160 CORROSION SERVICE PIPING

Taylor Forge & Pipe Works—Taylor Forge Bulletin 485, Corrosion Service Piping is a comprehensive treatment on stainless steel and nickel alloy anti-corrosion and anti-contamination piping. Economics, standards, advantages of welding, extensive technical data, design tips, and complete dimensional information on stainless fittings and flanges are included in the 32-page, profusely illustrated bulletin.

161 DEEP DRAWING PROCESS

Hydropress, Inc.—Folder describing "Marform" which is a new precision Deep Drawing Process developed by the Glenn Martin Co., Baltimore, Md. Deeper draws than heretofore in one operation, reduced tool costs, economical production regardless of quantities are only a few of the advantages. Marform units can be adapted as well to new equipment as to existing installations.

162 RUBBER AND PLASTICS MILLS

Farrel-Birmingham Co.—New 40-page Bulletin (No. 173) gives rubber and plastics mills the most comprehensive coverage that has yet been made available in booklet form. Contents include a table of sizes, capacities, power requirements, overall dimensions and other data on standard mills; general specifications, including details of a variety of attachments; parts lists of single and twin mill units, keyed to assembly drawings, and more than 30 illustrations of various types of rubber and plastics mills, from the smallest to the largest sizes.

The "Buyer's Catalog Guide" offers readers of MECHANICAL ENGINEERING an opportunity to secure advertisers' latest industrial literature available. In this issue there are 162 items to make selections from. For convenience an index may be found on pages 41 and 42. Select desired catalogs by number, fill in coupon on page 42 and mail promptly. (*Must be mailed on or before date given on coupon.*)

Use This Free Literature Service—
Mail The COUPON on Page 42 Today

• Keep Informed . . .

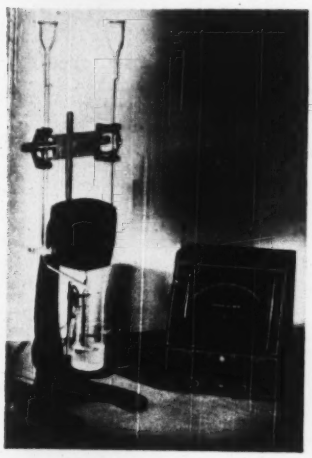
Announcements of current advertisers
in MECHANICAL ENGINEERING
and A.S.M.E. MECHANICAL CATALOG

• NEW EQUIPMENT
• BUSINESS CHANGES
• LATEST CATALOGS

Available literature or information may be secured by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as a source.

• NEW EQUIPMENT

Titration-pH Test Unit



Central Scientific Co. offers a new A.C. line-operated Titration-pH Unit for fast and accurate titration, precise control of neutralizations, oxidation-reduction reactions and precipitations, and pH measurements. Among its more important applications are the determination of manganese in iron and steel; electrometric measurement of pH values of aqueous or partly nonaqueous solutions; tests for acid and base numbers of petroleum products; sampling and chemical analysis of inorganic alkaline detergents; tests for dissolved oxygen in industrial waters, and the saponification number of petroleum products.

The Cenco Titration Unit is also suggested for use in ferrous analyses, and for the determination of the following components: arsenic, chromium, copper, manganese, nickel, nitrogen, phosphorus, selenium, sulfur, tin and vanadium. Aluminum may be studied for content of calcium, chromium, copper, iron, magnesium, manganese and tin.

For literature, write Central Scientific Co., 1700 Irving Park Road, Chicago 13, Ill.

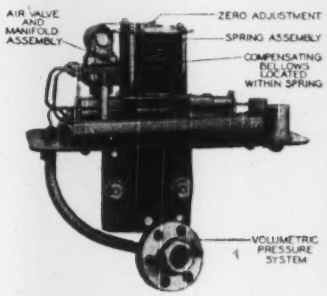
New Force-Balance Pressure Transmitter Announced

A new force-balance type of a pressure transmitter called the "Transaire," Pressure Transmitter has just been announced by Taylor Instrument Companies. This instrument was developed as a companion to the Taylor "Transaire" Temperature Transmitter to offer for the first time convenience and accuracy of suppressed ranges at high pressure levels.

The "Transaire" Pressure Transmitter makes it possible to measure and transmit up to 1000 feet the smallest of pressure changes with an accuracy of $\frac{1}{2}\%$ of the range span. Such accuracy offers closer control to instrument users.

A few of the instrument's outstanding features are: (1) "Narrow Range Spans" of 20 to 40 psi are available over range limits of 35 to 415 psia with sensitivity of .1% or .02 or .04 psi depending on range span used.

(2) "Volumetric Type Pressure System" has Type 316 stainless steel connection and pressure sensitive diaphragm. The solid filled volumetric pressure system was incorporated into the design of the "Transaire" Pressure Transmitter as a means of protecting the relatively thin and sensitive metallic diaphragm in the capsular chamber from process materials which might have a corrosive effect.



(3) "Standardized 3 to 15 Psi Output Air Pressure" regardless of the pressure range or span, the output of the transmitter is always linear from 3 to 15 psig. This calibration feature eliminates the necessity for individual calibration of matching receivers or receiver-controllers. Instrument transmits an output pressure which is proportional to the measured pressure with an accuracy of plus or minus 0.06 psi.

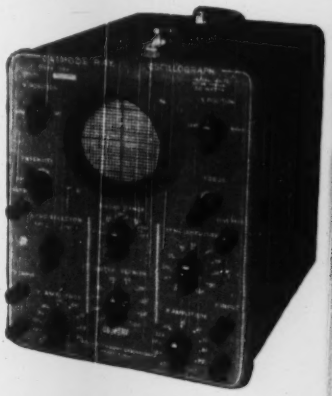
(4) "Operating Ranges can be Varied" with range limits by a simple screw driver adjustment. Continuous adjustment of any range span can be made within the range limits of the instrument.

(5) "Range Limits Can Be Shifted" when operating conditions change or it is necessary to transfer the instrument from one application to another having an operating range beyond the range limits, the transmitter is so constructed that the spring sub-assembly can be changed.

For further information, write Taylor Instrument Companies, Rochester 1, N. Y.

New 3" Oscillograph of Increased Portability

Du Mont Type 292 Cathode-ray Oscillograph which supersedes the time-honored Type 164-E, is announced by the Instrument Division of Allen B. Du Mont Laboratories, Inc., Clifton, N. J. This new 3" instrument marks a new high in portability, combined with features heretofore found only in 5" models.



The increased portability is largely due to the new Du Mont Type 3RP-A 3" Cathode-ray Tube with its extremely short overall length of 9¹⁵/₁₆". The instrument weighs only 21 lbs., measures 10 ⁷/₈" h., 8¹³/₁₆" w., 11" d.

The sensitivity of the deflection amplifiers has been increased, so that input signals of 0.4 rms volt and 0.56 rms volt will produce 1" deflection on vertical and horizontal axes respectively. Owing to the flat face of the Type 3RP-A Tube, optical distortion is kept at a minimum. X-axis and Y-axis amplifiers supply their respective pairs of deflection plates with voltages that are 180° out of phase. This balanced deflection virtually eliminates astigmatic defocusing and trapezoidal distortion which are unavoidable with unbalanced deflection. The gas-triode linear time-base generator provides recurrent sweep frequencies from 8 to 30,000 cps, synchronized with either the vertical amplifier or some external source.

Additional information on the new Type 292 Oscillograph may be obtained by writing Du Mont.

The New "Di-Acro" Hydra-Power Bender

The "Di-Acro" Hydra-Power Bender—is an entirely new product of O'Neil-Irwin Mfg. Co., 308 Eighth Ave., Lake City, Minn.

This company is now in its tenth year of manufacturing the manually operated "Di-Arco" Bender which has proven so popular throughout all phases of industry in both experimental and production operations.

The New "Di-Acro" Hydra-Power Bender which now has been developed is equally as flexible and universal in its application as the various sizes of their hand operated Benders...

Continued on Page 62

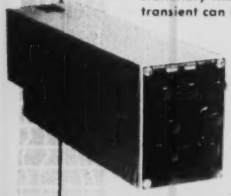
THE HATHAWAY SC-16A SIX ELEMENT
RECORDING CATHODE-RAY OSCILLOGRAPH

NEW HIGHS IN RESOLUTION are obtained by this new oscillograph because of its unusually HIGH FREQUENCY RESPONSE and HIGH CHART SPEED...designed for recording fast transients and continuous phenomena.

FREQUENCY RESPONSE 0 to 200,000 cycles per second
RECORDS up to 1000 ft. long at speeds up to 600 inches per second
RECORDS up to 10 ft. long as speeds up to 6000 inches per second
WRITING SPEED above 100,000 inches per second

Note these additional unusual features.

- SIX ELEMENTS with convenient interchangeable lens stages for 1, 2, 3, or 6 traces on full width of chart.
- INTERCHANGEABLE RECORD MAGAZINES for CONTINUOUS RECORDING on strip chart, either 6 inches or 35mm in width up to 1000 feet in length, DRUM RECORDING for short, high-speed records, and STATIONARY CHART for very short transients.
- PRECISION TIMING EQUIPMENT, tuning fork controlled, for 1-millisecond or 10-millisecond time lines.
- Crystal-controlled Z-AXIS MODULATION for 1/10 millisecond time marks.
- QUICK-CHANGE TRANSMISSION for instantaneous selection of 16 record speeds over a range of 120 to 1.
- AUTOMATIC INTENSITY CONTROL.
- CONTINUOUS SWEEP OSCILLATOR which permits viewing as well as recording.
- Single-pulse LINEAR OSCILLATOR for recording transients on stationary film. The record can initiate the transient to be recorded, or the transient can initiate the record.



Each recording element is a complete unit, fully housed, which can be instantly inserted or removed. Recording element contains high-intensity cathode-ray tube, and both AC and DC amplifiers. Control panel is located on outside end.

FOR FURTHER INFORMATION, WRITE FOR BULLETIN 2 G 1K

Hathaway
INSTRUMENT COMPANY
1315 SO. CLARKSON STREET • DENVER 10, COLORADO

• Keep Informed

which means that this Power Bender can be easily set for the bending of tubing, angle, channel, extrussions, mouldings, strip stock, bus bars, round or square rods and all other solid ductile materials.

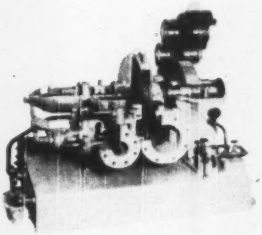
The primary reason for offering this power machine is that many of their customers have requirements for bending materials somewhat beyond the capacity of the hand operated units and also have production runs of such size that manual operation is impractical.

The "Di-Acro" Hydra-Power Bender can be efficiently employed in practically every metal working plant since it can be quickly changed over from one job to another and the simple tooling required for this wide variety of operations can be readily prepared right on the job.

Then too, a complete range of standard bending accessories for both solid materials and tubing is available from their factory and because of the simplicity of design these special parts are very inexpensive.

Westinghouse Type E Gearturbines Available

Type E industrial steam turbines with close-coupled, integral reduction gears for low-speed applications are available from Westinghouse Electric Corp. Equipment such as pumps, fans, compressors, and generators can be driven at their proper speeds by these Gearturbines while the turbines operate at their most efficient speed.



The new units combine a rugged, compact speed reduction mechanism solidly coupled to the Type E turbine and designed to operate as a single unit. Three machined feet form a firm three-point support for the unit. Single helical gears with low helix angle give low thrust against bearings. Endwise movement of one shaft does not affect axial location of the other and thrust is not transferred from the gears to the turbine. Turbine and gear are factory aligned on a single, heavy plate.

• Keep Informed

steel base which also serves as an oil tank. Additional steel members maintain rigidity and resist torsional distortion. The Gearturbine is shipped as a completely assembled unit ready to install.

Gearturbines are available with standard gear reduction ratios for the best operating speeds of the usual types of loads.

For further information write Westinghouse Electric Corp. P. O. Box 2099, Pittsburgh 30, Pa.

New Yale Worksaver Handles Kegs, Cylindrical Cardboard Containers, and Drums, Without Pallets

The Yale & Towne Manufacturing Co., Philadelphia Division, announces a new Worksaver development which equips the tilting fork model of the battery-powered hand-truck line with hydraulically operated fingers which grasp and pick up drums, cylindrical cardboard containers, and kegs without the use of pallets or skids. The truck tiers from 1 to 6 cylindrical containers 2, 3 and 4 layers deep. The fingers grasp the load from above and suspend it for handling, rather than support it from below.

The truck is particularly advantageous when loading and unloading freight cars and street trucks because containers do not have to be manually placed on or taken off pallets or skids for handling. The truck eliminates pallet inventories which may tie up thousands of dollars where large quantities of such commodities as oils, batching ingredients, chemical powders, nails, screws and bolts must be stored either for shipment or future use.

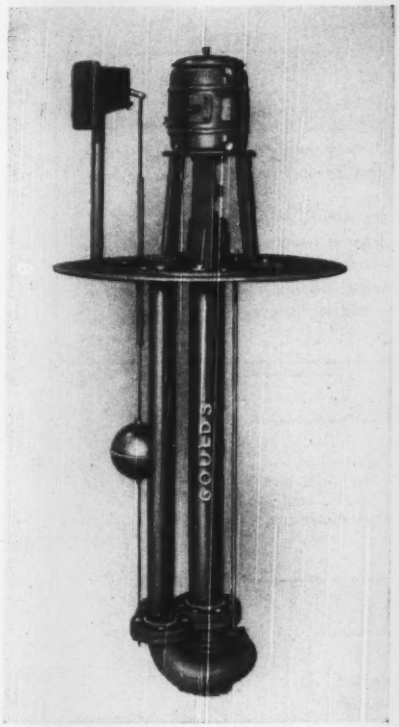
The battery powered hand truck weighs 3845 lb. Its overall height is 83". Outside dimensions are 32-3/4" × 77-1/8", excluding the grasping mechanism. The truck travels three miles per hour with no load, two miles per hour under full load. Truck lifts 15 feet per minute with 3,000 lb load. Operation of the hydraulic fingers is controlled by levers located at the front of the truck. Lifting and lowering are also controlled from levers at the front of the truck. Forward and reverse speeds are controlled from the handle of the truck. When the steering handle is in either the vertical or horizontal position the truck brake is automatically applied to prevent accidental movement.

Manufacturing Geon Covered Flexible Metal Conduit

Chicago Metal Hose Corp., a leader in the manufacture of Flexible Metal Hose and Tubing for industry, announces an added type Geon covered flexible metal Machine Tool Conduit to its extensive line.

This Geon covered conduit may be used for electrical shielding purposes in many applications and is particularly suited for use on machine tools because of its resistance to moisture, coolants, greases and oils. The tough, abrasion-resistant cover is applied over a highly flexible galvanized steel convoluted steel tubing. This durable steel

Continued on Page 64



Goulds vertical centrifugal Fig. 3047

For Dependable Heavy Duty Sump and Drainage Service

This rugged, heavy duty sump pump gives exceptional service in removing water from boiler room pits, pipe tunnels, elevator pits, cellars, basements. It is also widely used for transfer service where automatic control of liquid levels in vats or tanks is required.

CAPACITIES Fig. 3047 is available in four sizes for pit depths from 3 to 20 feet. Capacities from 10 to 650 G.P.M. with heads up to 130 feet depending upon capacity.

ADVANTAGES The unit comes complete with float, automatic switch and cover plate. The discharge pipe, pump support column and the cover plate are welded into a rigid unit assuring permanent alignment of upper and lower bearings. Lower bearing is protected by special pressure equalizing system to give long wear.

MEMBER HYDRAULIC INSTITUTE U.S.A.

For complete information call or write Pump Headquarters or your nearest Goulds dealer. Ask for Bulletin 726.1.

Goulds PUMPS INC. Seneca Falls New York

QUICK FACTS about S.S.WHITE FLEXIBLE SHAFTS

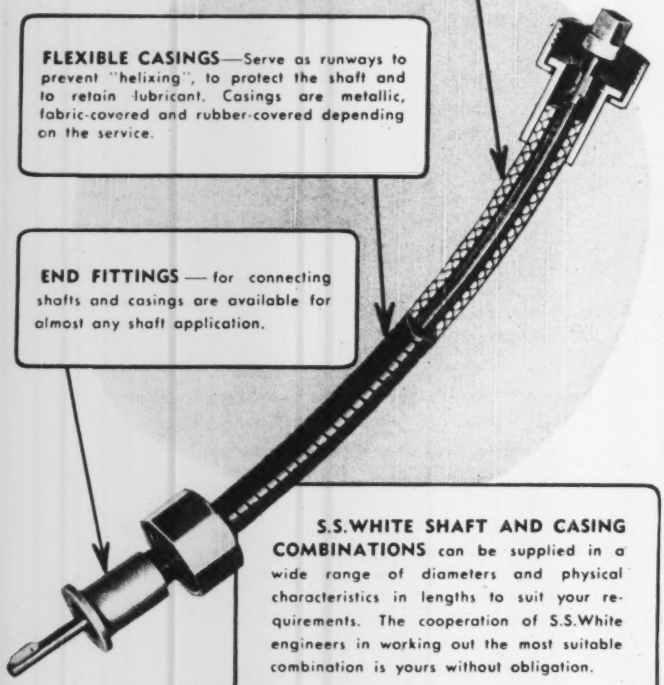
They are made in two classes:

POWER DRIVE—For transmitting rotary power to instruments and other mechanisms from small motors or other power sources.

REMOTE CONTROL—For the control of parts that require automatic or manual adjustment from a remote point. Remote control shafts are engineered for smooth, sensitive control because they have minimum torsional deflection, approximately equal deflection in either direction of rotation and low internal friction.

FLEXIBLE CASINGS—Serve as runways to prevent "helixing", to protect the shaft and to retain lubricant. Casings are metallic, fabric-covered and rubber-covered depending on the service.

END FITTINGS — for connecting shafts and casings are available for almost any shaft application.



S.S.WHITE SHAFT AND CASING COMBINATIONS can be supplied in a wide range of diameters and physical characteristics in lengths to suit your requirements. The cooperation of S.S.White engineers in working out the most suitable combination is yours without obligation.

SEND FOR BULLETIN 4501

It gives basic facts about flexible shafts and their selection and application.
Write for free copy today.

S.S.WHITE INDUSTRIAL DIVISION
THE S. S. WHITE DENTAL MFG. CO. — DEPT. L, 10 EAST 40th ST., NEW YORK 16, N. Y.
FLEXIBLE SHAFTS AND ACCESSORIES
MOLDED PLASTICS PRODUCTS—MOLDED RESISTORS
One of America's AAAA Industrial Enterprises

• Keep Informed

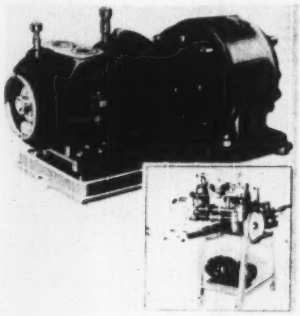
core and tough Geon cover provides a conduit to withstand abuse of installation and the wear of long usage.

This conduit is extremely flexible—will not bind or restrict movement when used between moving parts on machine tools. Liquid-tight steel fittings are usable with both standard and water-tight conduit boxes. They are attachable and re-attachable by the user or can be permanently attached by the manufacturer. Conduit is manufactured in sizes from 3/4" I.D. to 2" I.D. and can be furnished in mill lengths or cut lengths.

For further information regarding this type Machine Tool Conduit and its applications write Chicago Metal Hose Corp., 1305 South Third Ave., Maywood, Ill.

New Kraissl Air Pump

Hackensack, N. J.—The Kraissl Co., of Hackensack, N. J., has announced the introduction of their new Class 23 Series Air Pump—for suction and pressure applications. Originally designed for specific application to the packaging and printing machinery fields, these new pumps are suitable for almost unlimited types of operations.



The Class 23 Pumps are dry lubricated—completely eliminating discharge oil vapors. In many operations, such as handling paper, food products, pharmaceutical preparations, etc., this is important. The complete absence of contaminating oil vapors results in substantial savings in time and materials, as well as industrial health. The displacement blades furnish their own lubrication—and take up their own wear. The blades are designed to be consumed after a reasonable length of time in continuous, heavy-duty service; replacement costs compare favorably with the cost of oil and service time required for oil lubricated pumps. Frederick Kraissl, Jr., President of the Kraissl Co., Inc., reports that in exhaustive field tests and actual applications, the amount of wear on the blades is running much lower than original design specifications.

The pumps are fanned-cooled, which provides positive cooling for continuous duty—over a wide range of service conditions. The outer casing design provides an enclosure for control of flow of cooling air, as well as furnishing a guard for the fan blades. Class 23 Pumps are available with a double extended shaft—for group installations driven by a single power source. Rotation is normally clock-wise, but counter clock-wise rotation is available when requested.

Class 23 Pumps are designed for operation at 1750 RPM so that they may be direct connected to electric motors of this standard speed; however, they are not restricted to this speed. Capacities range from 5 Cubic

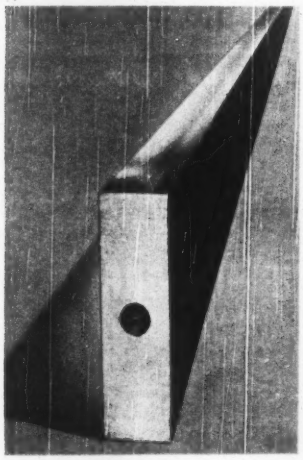
• Keep Informed

Feet Per Minute to 20 Cubic Feet Per Minute, for single units; larger capacities by group drive. Some of the applications where the Kraissl Class 23 Pumps are especially adaptable are: suction feed or pick-up of paper, cardboard, tin, etc.; filling of containers—bags, bottles, tubes, etc.; automatic handling on conveyor systems; printing presses and vacuum printing frames; photo composing machines; vacuum veneering; packing in crates and cases; vacuum holding chucks; vacuum filling machines; vacuum priming of centrifugal pumps; and vacuum filtration. Complete data is available in Kraissl's Bulletin A-1399; which will be gladly forwarded on request.

Inset photo shows Kraissl Class 23 Pump in actual installation on an automatic sealing machine. The Class 23 Pump provides the suction and pressure for the feeding of catalogs and literature as well as the sealing operation. The smooth, elastic action—as well as the complete absence of oil vapors—and the adjustable pressure points through relief valves were the features that made this manufacturer select Kraissl 23 Air Pumps for all his machines.

Nuclear Physics Research Poses Unusual Brass Mill Problem

Brookhaven National Laboratory, Associated Universities, Inc., Upton, Long Island, required 23,000 feet of high conductivity, soft annealed copper bar, to be used as magnet winding for the "Cosmotron" or Proton Synchrotron, a huge atom smasher, which is part of the equipment for a nuclear physics development program.



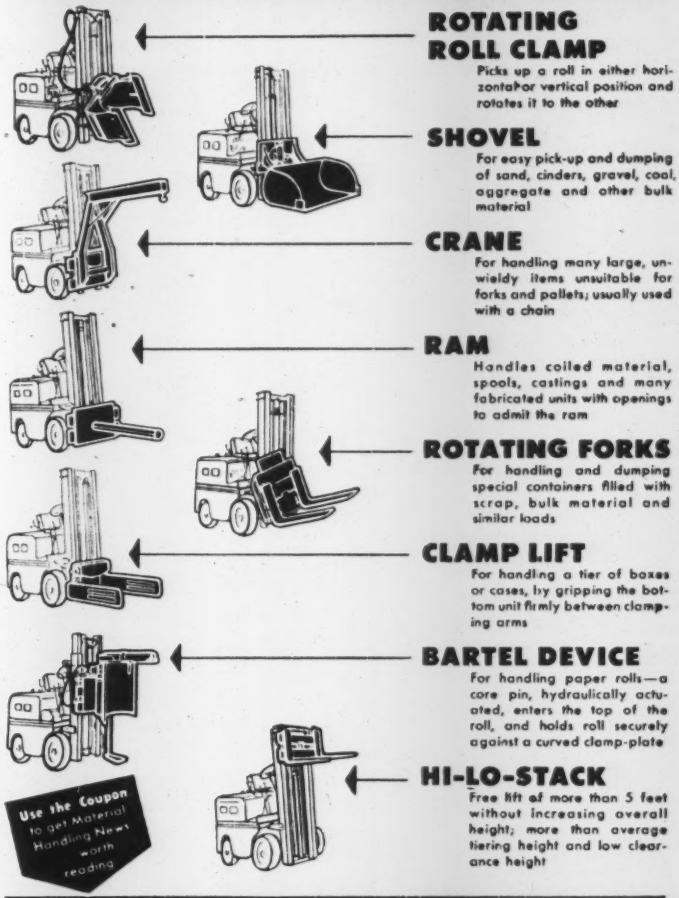
Two sizes of bar were required, the larger having a 2.182" x .750" cross section, in lengths varying up to 52'6". The smaller sections had a cross section 1.875" x .750" and were to be in various lengths up to 47'8".

Nothing unusual so far. But these long conductors had to have a small hole throughout their entire length to carry cooling water. Tolerances were moderate, but the specification required that the hole have an area of .0941 square inches, (slightly under 3/16" diameter), and must fall within a half-inch circle at the section's true center.

The required 150,000 pounds of these special sections were produced successfully on a 2500 ton extrusion press at the Buffalo Branch of The American Brass Co.

Continued on Page 66

CLARK *Attachments* MAKE THE CLARK FORK TRUCK "MANY MACHINES IN ONE"



ROTATING ROLL CLAMP
Picks up a roll in either horizontal or vertical position and rotates it to the other

SHOVEL
For easy pick-up and dumping of sand, cinders, gravel, coal, aggregate and other bulk material

CRANE
For handling many large, unwieldy items unsuitable for forks and pallets; usually used with a chain

RAM
Handles coiled material, spools, castings and many fabricated units with openings to admit the ram

ROTATING FORKS
For handling and dumping special containers filled with scrap, bulk material and similar loads

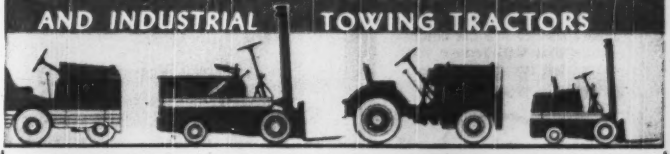
CLAMP LIFT
For handling a tier of boxes or cases, by gripping the bottom unit firmly between clamping arms

BARTEL DEVICE
For handling paper rolls—a core pin, hydraulically actuated, enters the top of the roll, and holds roll securely against a curved clamp-plate

HI-LO-STACK
Free lift of more than 5 feet without increasing overall height; more than average tiering height and low clearance height

Use the Coupon to get Material Handling News worth reading

CLARK ELECTRIC AND GAS POWERED FORK TRUCKS AND INDUSTRIAL TOWING TRACTORS



INDUSTRIAL TRUCK DIVISION • CLARK EQUIPMENT COMPANY • BATTLE CREEK 88, MICH.

Please send the items checked . . . without obligation ☐ Condensed Catalog ☐ Material Handling News

NAME_____

FIRM NAME_____

STREET_____

CITY_____ ZONE_____ STATE_____

AUTHORIZED CLARK INDUSTRIAL TRUCK PARTS AND SERVICE STATIONS IN STRATEGIC LOCATIONS

D. A. STUART'S

ThredKut

Reduces Cost of Machining Spindle Gears by 50%

ROTATING barbed spindles in the International Harvester cotton picker are the mechanical "fingers" which pluck cotton in modern fields.

In cutting SAE 8640 gears for these spindles on Gleason Revacycles, a dilution of Stuart's THREDKUT 99 reduced oil costs by 50%.

On the spindle broaching operation, done prior to barbing, this same Stuart product is performing with excellent results. The spindles are C1117 steel, hardness 83 on the Rockwell B scale.

On standard or special operations you will find that Stuart cutting fluids plus Stuart service are the combination that will reduce your costs. Ask for literature.

our 85th Anniversary Year!

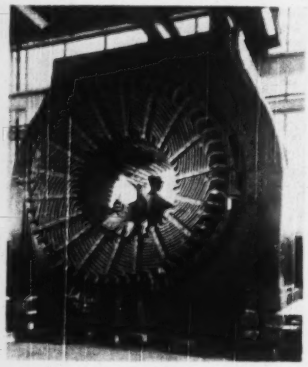
D.A. Stuart Oil CO.

2741 S. Troy St., Chicago 23, Ill.

• Keep Informed

To meet the requirement of 100% I.A.C.S. electrical conductivity, Anaconda Electrolytic Tough Pitch Copper was used for these extruded-and-drawn hollow magnet conductors, with certified conductivity reports going to Brookhaven.

70-Ton Stator Moved for Rewinding



It used to be that when a piece of electrical apparatus weighing some 70 tons was put into place it was there permanently. If anything wore out in later years, a repairman was sent to live with the apparatus until a rejuvenating job could be completed. Employes of the Westinghouse Manufacturing and Repair Plant in Chicago, however, recently moved the 70-ton stator of a 12,500-kva turbo-generator right into the plant for rewinding for a higher voltage.

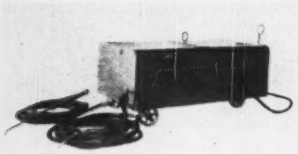
By bringing the job to the fully-equipped shop, time required for the rewinding is considerably reduced.

The giant stator, one of a pair which has been in operation at the Inland Steel Company for 26 years, is 12 feet high, 13 feet wide and 18 feet long. Each of the stators is rated at 2,400 volts. Rewound with new, factory-designed coils, the stators will each be stepped up to 7,050 volts.

Material alone for each stator consists of nine boxes of coils, plus rewinding material weighing 11 tons. Each coil weighs 165 pounds in itself.

All-Electric Steam Cleaner

An All-Electric Steam Cleaner designed especially for use underground, or wherever gaseous or explosive mixtures have previously made cleaning impractical, is announced by the Hypressure Jenny Division of Homestead Valve Manufacturing Co., Coraopolis, Pa.

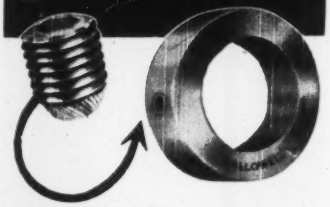


Known as the Homestead-Yeager All-Electric Steam Cleaner, the unit is electrically heated and electrically powered. It is said to remove grease, dirt, and other deposits from machinery, equipment, floors, etc., ten times faster than by hand-methods.

The All-Electric Steam Cleaner properly mixes a constant amount of water with the

HALLOWELL

Steel Collars



HALLOWELL Solid Steel Collars, functionally proportioned throughout . . . precision-machined so faces run perfectly true . . . are beautifully polished all over . . . yet they cost less than common cast iron collars. 3" bore and smaller are made from Solid Bar Stock. To make sure the collar won't shift on the shaft, they are fitted with the famous UNBRAKO Knurled Point Self-Locking Socket Set Screw—the set screw that won't shake loose when once tightened. HALLOWELL . . . a "buy word" in shaft collars . . . available in a full range of sizes for IMMEDIATE DELIVERY.

Write for name and address of your nearest HALLOWELL and UNBRAKO Industrial Distributors.

See us at Space 128 A.S.T.E. Exposition April 10-14, Convention Hall, Philadelphia

STANDARD PRESSED STEEL CO.

JENKINTOWN 20, PENNSYLVANIA

Do you know that every year thousands of plants are made

SAFER
MORE COMFORTABLE
MORE EFFICIENT

IRVING GRATINGS

(OPEN STEEL MESH FLOORING)

IRVING "DUPLEX" GRATING IN ANNEALING PLANT...

● WRITE FOR CATALOG

IRVING SUBWAY GRATING CO. INC.
ESTABLISHED 1902
Home Office and Plant: 50th 27th Street
LONG ISLAND CITY 1, NEW YORK
Western Division: Foot of Park Ave.
EMERYVILLE, CALIFORNIA

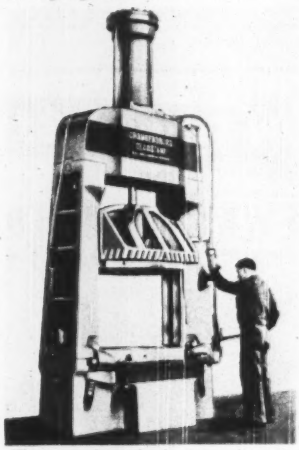
• Keep Informed

desired amount of dissolved cleaning compound, and pumps the mixture through a manifold where it is electrically heated in progressive stages. At 100 to 120 pounds normal operating pressure, the boiling hot solution and vapor are ejected from the cleaning gun in a powerful 60 gallons per hour blast that cuts, dissolves, and flushes away the heaviest dirt and grease deposits.

Portable either by means of its own wheels or its balanced crane hook eye, the Homestead-Yeager Steam Cleaner is made in the Standard, SPA series, approved by the Pennsylvania Department of Mines for use in fresh air underground; and in "Permissible," BMA series which will carry U. S. Bureau of Mines approval. The units are available for practically any power circuit; and have a demand of 50 kw. Approximate weight: 800 lb. Dimensions: 66" x 36" x 32" high. The manufacturer will send free literature upon request.

Chambersburg Offers New Cecostamp

A new Cecostamp, Model "L", is announced by Chambersburg Engineering Co., Chambersburg, Pa., originators of this form of air-operated drop stamp. The Cecostamp uses impact blows of controlled intensities to produce a wide variety of metal shapes from any of the formable metals. The new Model "L" Cecostamp, 10% more powerful than preceding Cecostamps, adds new features suggested by users of Cecostamps over the past fifteen years or originated by Chambersburg engineers.

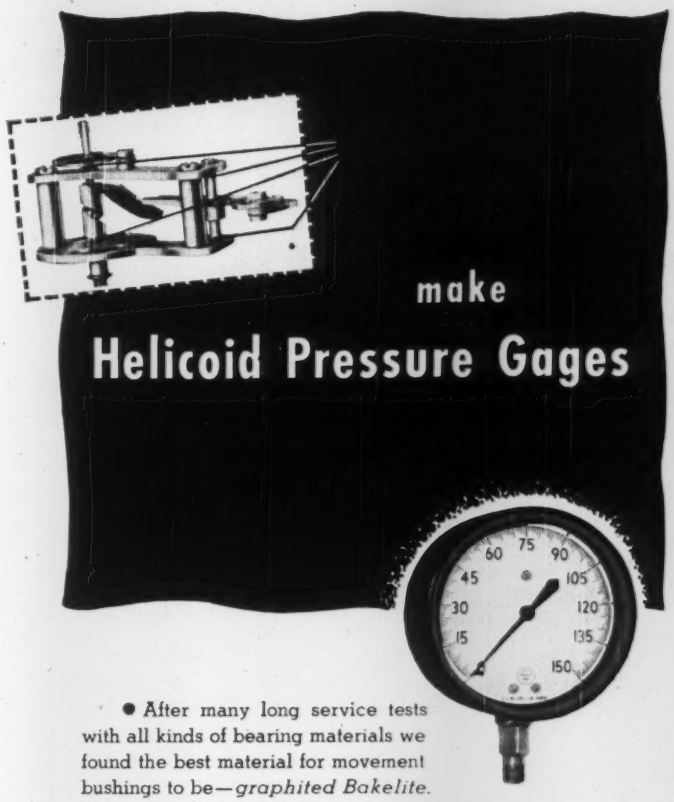


The control mechanisms are located in such a position that the operator is free of moving parts. With the overhead safety rest control, the operator stands solidly on both feet and both hands are occupied and cannot be under the die. Frame-to-anvil bolts and springs are recessed avoiding hazards to clothing. Positive self-positioning safety rests, built into the side frames between the guides, hold the ram when changing dies or working between dies.

A steel bolster plate on the anvil equipped with "T" slots makes for rapid and accurate setting of dies. More production is possible due to the time saved in lining up and checking match of the dies.

The Model "L" Cecostamp is ruggedly built, and in addition is provided with shock insulating features to cushion vital parts, resulting in remarkably low maintenance

Continued on Page 68

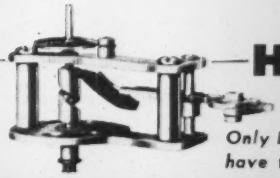


● After many long service tests with all kinds of bearing materials we found the best material for movement bushings to be—*graphited Bakelite.*

Graphited Bakelite bushings outwore all others—ran 50,000,000 full stroke cycles at 700 cycles a minute with negligible wear, no corrosion, no distortion from impact.

Among other tests, one of the largest public utilities found that HELICOID GAGES with these bushings lasted four times longer than any other gage tested under the same severe conditions.

Helicoid movements with graphited Bakelite bushings have less static and kinetic friction. They are now standard in all Helicoid gages—at no extra cost.



HELICOID

Only Helicoid Pressure Gages have the Helicoid Movement

ACCO

TRADE MARK

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE COMPANY, INC.
Bridgeport 2, Connecticut

costs. For example, Fabreeka pads cushion the yoke-to-frame joints, and automatic lubrication of valve cylinder and guides prolongs the life of these parts, the lubricator being turned on automatically as soon as the Cecostamp is operating. Valves are cast integral with the yoke, eliminating piping and air losses.

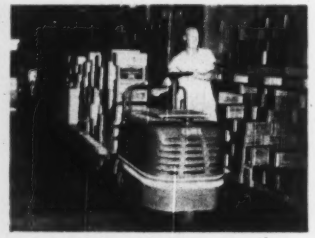
The Model "L" Cecostamp has been successfully adapted to the manufacture of bus and automobile bodies, sheet metal aircraft parts, rail cars, home appliances, agricultural implements and numerous other products. Almost every day brings word of a new Cecostamping. The new Cecostamp meets the demand for greater capacity that has resulted in the use of hundreds of these tools in forming, shaping, drawing and stamping metallic sheets.

New Light Tractor, Clarkette-5, Speeds Order-Selection Work

A new towing tractor, which need not be ridden to be operated, and which despite its comparative tininess will tow ten tons on trailers over a level course at speeds from 1 to 6.5 M.P.H., has just been announced by the Industrial Truck Div. of the Clark Equipment Co., Battle Creek, Mich.

The new tractor the Clarkette-5 is unique in that the driver need not ride; he can operate the machine while walking on either side of it. The advantage of this feature is that it facilitates order-selection work, for which the tractor was designed, in that "pulling" or "picking" items is removed from the off-again-on-again, walk-and-carry category to one of smooth flow at a saving of time and energy.

In one of the country's largest wholesale grocery warehouses, where the Clarkette-5 has undergone extensive use prior to its release for production, the Clark Equipment Company claims, 9,000 pounds have been "picked" per man hour as against 7,000



pounds credited to one of the previously-used machine methods, and 4,500 pounds credited to another which, by the way, involved the labor of three men and a tractor. The Clarkette-5 method employs only one man to a tractor and train.

In another large warehouse in which the new tractor has been installed, and where it has undergone "acid tests" according to Clark, its operator consistently "picks" 140 pieces, or items, per man hour as against 100 to 110 credited to the method it has displaced.

A combination clutch-and-throttle control bar extending across the width of the Clarkette-5 above the cowl, makes possible ease of control and driving while the driver is walking. By simply moving the bar forward, the driver can move the tractor and train a few feet at a time, or from item to item in the order-selection line. The weight of the train acts as a brake, thus giving the driver maximum time to pick and place items on the trailers.

If positive braking is necessary while the driver is walking, he simply touches a foot to the brake bar at the rear of the driving platform. The parking brake is actuated by electricity and is controlled by a toggle switch on the instrument panel.

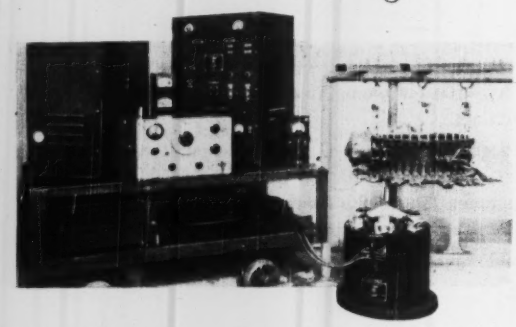
In normal driving position, the operator stands on a platform only a few inches higher than the floor. Mounting and dismounting is "as easy as taking a normal step," according to Clark. A back rest provides safety and comfort for the driver while mounted. The large steering wheel is centered over the cowling so that it can be handled easily from any operating position.

Steering is unnecessary when the Clarkette-5 is driven by a walking driver on a flat surface, since the castered steer wheel insures perfect tracking once it is positioned. The single steer wheel gives the machine an exceptionally small turning radius and extraordinary maneuverability in narrow aisle.

The Clarkette-5, while developed originally for wholesale grocery warehousing, already has demonstrated usefulness in textile and transportation fields, Clark reports. The machine is not yet available for export sale.

A bulletin containing complete specifications on this new towing tractor may be secured by writing to the Clark Equipment Co., Industrial Truck Division, Battle Creek, Mich.

YOU CAN BE SURE.. IF IT'S Westinghouse



Explore . . . Test . . . Remedy

It pays off to fatigue test materials *before* production starts. Westinghouse Type HI Vibration Fatigue Equipment, illustrated above, has been designed to supply the resonant drive force needed in fatigue testing operations. Write for complete information on this or other vibration testing equipment. Westinghouse Electric Corporation, Department E-1, 2519 Wilkens Avenue, Baltimore 3, Maryland. J-02210

Westinghouse
VIBRATION EQUIPMENT

VIBRATION Fatigue Tests POINT THE WAY TO IMPROVED PRODUCTS

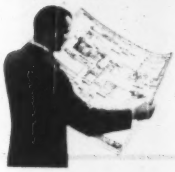
MODEL 100VA
CAPACITY 100 Lbs.
Produces Vibrations Vertically

You can be sure if your products pass a vibration fatigue test—substantiates design and construction materials—frequently exposes excessive material. Many things can be learned from tests. A "must" for electronic, aircraft and automotive parts and assemblies. Hundreds in use. Models to handle parts from 10 lbs. to 100 lbs.—choice of vertical or horizontal table movement. Frequencies of 600 to 3,600 v.p.m. Special machines to order. Catalog F contains treatise.

Made by the makers of All American 16X Microscope for carbide surface inspection

ALL AMERICAN
Tool & Manufacturing Co.
1016 FULLERTON AVE., CHICAGO 14, ILL.

Designed for industrial microfilming requirements



...Kodagraph Micro-File Equipment

TO CONDENSE, PRESERVE, PROTECT YOUR DRAWINGS...THE KODAGRAPH MICRO-FILE MACHINE

Place an engineering drawing on the copyboard . . . touch a foot-switch . . . and the machine does the rest—

Instantaneously, it takes the picture at great reduction . . . advances the film . . . is ready for the next drawing.

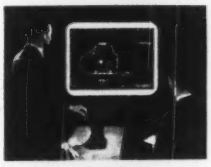
In this manner you can record documents—large or small—bound or unbound. Do it conveniently . . . speedily . . . whenever the demand arises.

4 different models now available

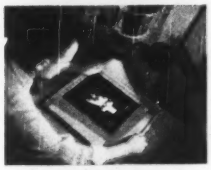
Kodagraph Micro-File Machines meet the wide range of requirements in engineering departments . . . and in the field. Each is a precision machine . . . designed by Kodak . . . made by Kodak to give you these advantages—

- You can reclaim 98% of your filing space . . . microfilm old records . . . then destroy them, if you wish.
- You can provide branch offices, repair depots with compact, duplicate records on positive microfilm.
- You can simplify reference work . . . file your 16mm. or 35mm. film records at your finger tips . . . ready for immediate review in the Kodagraph Film Reader.

To view your microfilm records in the office . . . the Kodagraph Film Reader. Each image is enlarged sharp and clear . . . easy to read and check . . . on a special green-tinted viewing screen. You can speed the film from image to image . . . get all the information you need—quickly.

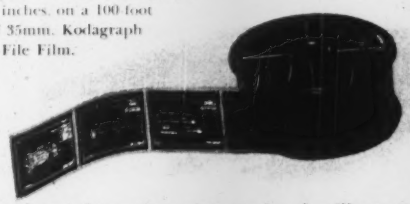


To view your microfilm records in the field . . . the Kodagraph Portable Projector. You can flash your records on any screen or light colored wall . . . magnified at dimensions up to several times larger than the original, if necessary. It is convenient to carry—weighs only twelve pounds.



To make enlargement prints from your microfilm records . . . the Kodagraph Micro-File Enlarger. It produces prints of maximum legibility . . . so sharp that they can be used as intermediates in direct process or blueprint machines.

In weighing the advantages of installing a Kodagraph Micro-File Machine in your engineering department . . . consider, too, the economy of the operation. You can record 675 drawings, size 24x36 inches, on a 100-foot roll of 35mm. Kodagraph Micro-File Film.



For complete information, write today for illustrated literature.

"Kodak" is a trade-mark

EASTMAN KODAK COMPANY
Industrial Photographic Division
Rochester 4, N. Y.

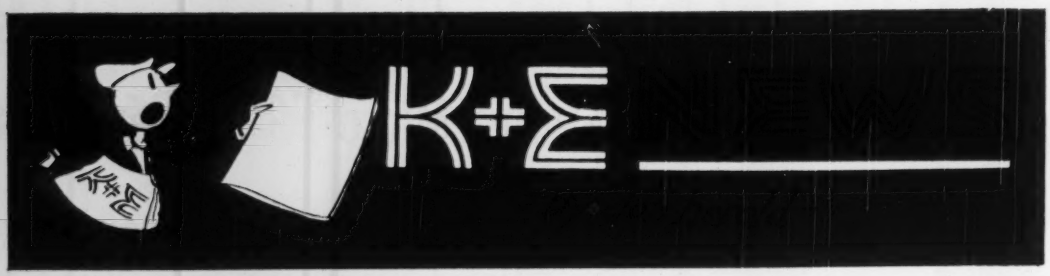
16

Eastman Kodak Company
Industrial Photographic Division
Rochester 4, N. Y.

Please send your literature illustrating Kodagraph Micro-File Equipment.

Name _____ (please print)
Department _____
Company _____
Street _____
City _____
State _____

Kodak



Here's the black-on-white steel tape that you might say is built with "hob nails". The name is WYTEFACE* "A".

It is made for a tough, rough-and-tumble, outdoor life. It is designed for dragging and for other forms of degradation which an engineer's tape must endure.

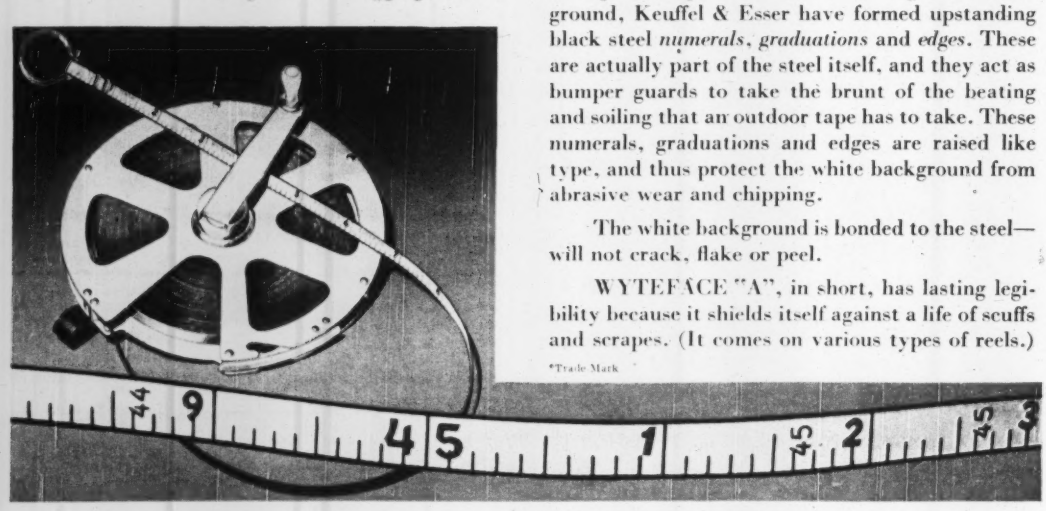
The explanation is:

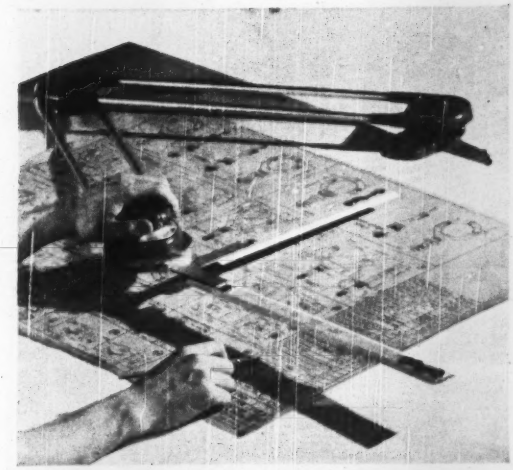
As a permanent and integral part of a basically strong steel tape which bears a lasting white background, Keuffel & Esser have formed upstanding black steel *numerals*, *graduations* and *edges*. These are actually part of the steel itself, and they act as bumper guards to take the brunt of the beating and soiling that an outdoor tape has to take. These numerals, graduations and edges are raised like type, and thus protect the white background from abrasive wear and chipping.

The white background is bonded to the steel—will not crack, flake or peel.

WYTEFACE "A", in short, has lasting legibility because it shields itself against a life of scuffs and scrapes. (It comes on various types of reels.)

*Trade Mark





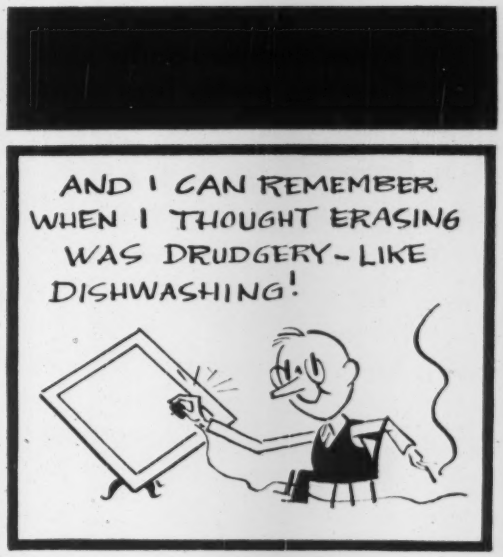
You wouldn't try to be Rachmaninoff without a piano, or a Kreisler without a fiddle. Well, who would want to be a draftsman without a K&E PARAGON† DRAFTING MACHINE?

This miracle machine makes you a veritable orchestra leader at your drawing board. It combines T-squares, triangles, protractors and scales, all in one unit, controlled entirely by one hand.

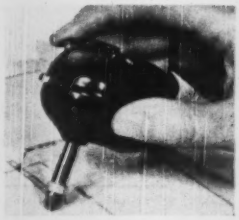
You can move a rule all over the board, and the rule stays parallel to its original position. You can draw all lines to exact length. The lightest touch rotates the scales to any angle desired.

Permanent accuracy is assured, because the open center arm construction makes it practically impossible to disturb the factory-set band tension.

†Trade Mark



This K&E MOTORASER* makes old-fashioned hand erasing look horse and buggy. It reduces your erasing time to seconds.



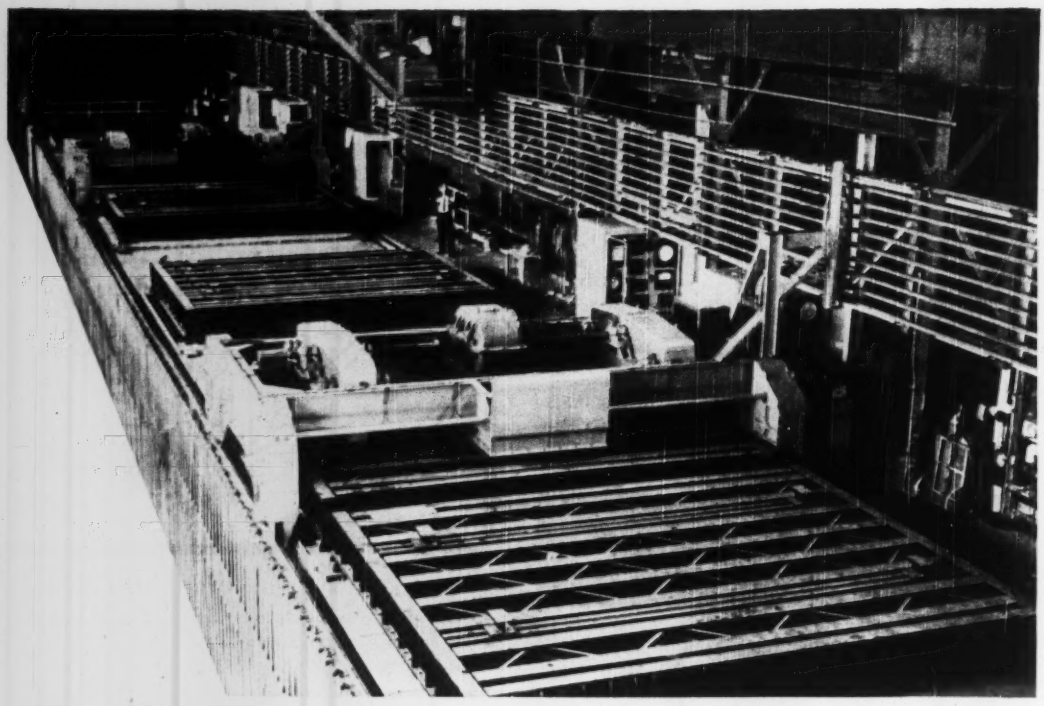
Since it depends on speed rather than pressure, the MOTORASER does not wear holes in paper. It's as accurate as a pencil point, yet will clean large areas in a jiffy.

It's handy in the hand—a 3 inch palm full with a finger-tip switch—only 6 oz. Uses AC juice—60 cycle 110 volt AC—or DC with an inexpensive adapter. A sturdy little feller, too.

*Trade Mark

For further information about any of the above products, ask a K&E Distributor or any K&E Branch, or write to Keuffel & Esser Co., Hoboken, N. J.

K&E
partners in creating
For 83 years K&E equipment and materials have been partners of the draftsman, engineer and scientist in shaping the modern world.



Soaking Pits by Amsler-Morton, with L&N Integrated Control; for uniform heating of ingots at both bottoms and tops; for scale control; for no "washing"; minimum fuel; long refractory life; ability to hold ingots in condition until needed.

Integrated Control Helps Mills Get Well-Heated Steel

WELL-HEATED steel—whether it's ingots, slabs, bars, blooms or forging stock—is steel at the right temperature, with the right surface, ready for processing at the right time. It's the kind of steel that the mill gets from good furnaces, operated by good men, with the best instrumentation to help.

Right now, when costs are high, here is welcome news about instrumentation which is helping to get well-heated steel *at lower cost.* This instrumentation is Integrated Control . . . L&N's newest means for regulating large furnaces.

An Integrated Control panel looks very much like any other panel for centralized automatic control, except that it includes an additional "key" instrument . . . the new L&N Fuel-Air Ratio Controller. This instrument adds to the panel a combustion control which matches your L&N Temperature Control in sensitivity and dependability; is designed specifically by L&N to go with its companion L&N equipment. As a result, Integrated Control brings closer-stepping coordination between furnace atmosphere, uniform temperature and correct draft; it helps mills get well-heated steel by efficient, economical operation. For folder, write Leeds & Northrup Company.

NEW FOLDER

Only 4 Pages—But Important to Cost-Conscious Executives!

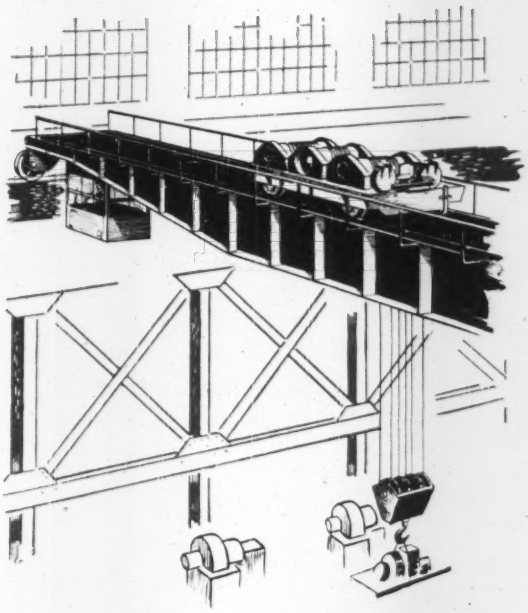
LEEDS & NORTHRUP COMPANY, 4963 STENTON AVE., PHILA. 44, PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Ind. Ad N-33-660(1)

FOR 19 YEARS
never a bearing failure with Farval



FARVAL—*Studies in Centralized Lubrication* No. 106

NINETEEN years ago, Farval Centralized Lubrication was installed on a 10-ton overhead traveling crane in one of the steel mills in the Chicago district. A recent report on this early job states that the Farval systems are still in service, as good as on the day they were installed, and that since 1930 the crane has never been down for a bearing repair or replacement. In short, there has never been a minute's trouble due to faulty lubrication.

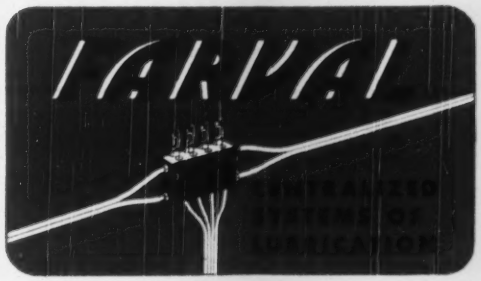
Two manually-operated Farval systems—one on the bridge and one on the trolley—serve 56 points of lubrication including the wheel bearings. In less than five minutes, every eight hours, the operator lubricates every bearing on the crane from two conveniently located hand pumps. No need to climb all over the crane and never a bearing is skipped. Grease consumption is greatly reduced because there is no waste, and drippage is practically eliminated.

More than 2000 Farval systems have been installed on cranes. Many of them are roller bearing cranes, where clean grease is essential and over-lubrication should be avoided.

Farval has proven itself in over 20 years of service. It is the original Dualine system of centralized lubrication that others imitate. The Farval valve has only 2 moving parts—is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble. Through its wide valve ports and full hydraulic operation, Farval unfailingly delivers grease or oil to each bearing—as much as you want, exactly measured—as often as desired. Indicators at every bearing show that each valve has functioned. For a full description, write for Bulletin No. 25.

The Farval Corp., 3264 E. 80th St., Cleveland 4, O.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.



C-E REHEAT BOILERS

DUNKIRK STEAM STATION

Niagara Mohawk Power Corporation

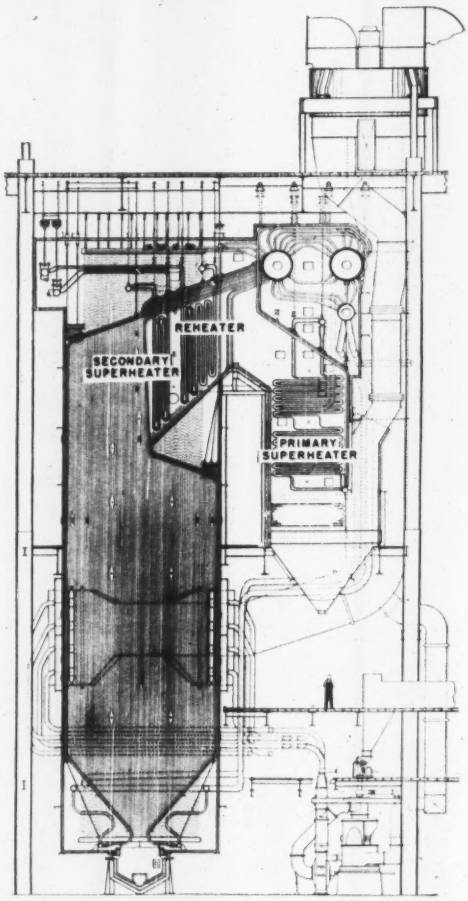
The C-E Unit, shown here, is one of two duplicate steam generating units of the reheat type soon to go into service at the Dunkirk Steam Station of the Niagara Mohawk Power Corporation.

Each of these units will serve a 100,000 kw turbine generator operating at an initial steam pressure of 1450 psi and a temperature of 1000 F reheated to 1000 F.

The units are of the radiant type with a reheater section located between two stages of the primary superheater surface. A finned tube economizer is located below the rear superheater section, and regenerative air heaters follow the economizer surface.

The furnaces are fully water cooled, using closely spaced plain tubes throughout. They are of the basket-bottom type, discharging to sluicing ash hoppers.

Pulverized coal firing is employed, using bowl mills and vertically-adjustable, tangential burners.



C-E

COMBUSTION ENGINEERING—SUPERHEATER, INC.

200 Madison Avenue • New York 16, N. Y.

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

YOU'LL LIKE THESE NEW R&M UNIVERSAL MOTORS

They Help You Solve Your Problems!

High starting torque; high operating speed; adaptability to speed control—to *these* inherent characteristics of series motors Robbins & Myers has added *many performance advantages.* New, completely redesigned R & M universal motors, from 1/100 to 1/3 horsepower, are ready *now* for powering your small equipment.

BETTER, INSIDE AND OUT

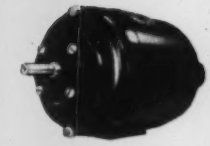
From their *dynamically balanced* armatures to their rigid, welded-steel shells, nothing has been slighted. Commutation, brushes, bearings, insulation, and ventilation all represent *true progress*—progress backed by the competence born of long, successful experience.

STANDARD TYPES—AND "SPECIALS," TOO

In the four frame sizes, there's the *right motor* for every need—sleeve or ball-bearing; fixed rotation or reversible; open or totally enclosed; standard or special ratings . . . and a *welcome variety* of housing types and end-heads.

YOURS FOR THE ASKING

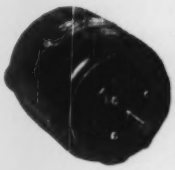
We'll be glad to send you literature on these new motors. And, if you would like to have R & M sit in on a discussion of *powering improvements*—that's yours for the asking, too. Address Robbins & Myers, Inc., Motor Div., Dept. F-40, Springfield 99, Ohio.



STANDARD PAD BASE

STANDARD LOW BASE
(Also "Medium" and "High" Types)

HUB MOUNTING



FACE MOUNTING

FLANGE MOUNTING

FOR MODERN, COMPACT PRODUCT STYLING—USE

MOTORS by ROBBINS & MYERS

Revised American Standard

CAST-IRON SCREWED FITTINGS 125 and 250 LB

This 1949 Standard for Cast-Iron Screwed Fittings 125- and 250 lb covers pressure ratings, sizes and methods of designating openings of reducing fittings, marking, minimum requirements for materials, dimensions and tolerances, and threading. To bring this Standard in line with current practice, 7 new sizes of reducing elbows, 29 sizes of reducing tees, and 18 sizes of reducing crosses have been added, the Introductory Notes have been revised, some of the tables have been rearranged, and provisions have been added for the making of caps by the green sand core process.

B16.4-1949 60¢

(20% discount to ASME Members)

A new standard reference covering the construction, maintenance, inspection, and operation of manlifts for conveyance of plant personnel.

SAFETY CODE FOR MANLIFTS

Manlifts covered by the scope consist of platforms or brackets mounted on, or attached to an endless belt, cables, or chains, or similar method of suspension, such belt, cables, or chains operating in a substantially vertical direction, and being supported by and driven through pulleys, sheaves, or sprockets at the top and bottom. Rules cover general and mechanical requirements, operation, inspection, and tests.

A90.1-1949 55¢

(20% discount to ASME Members)

GASEOUS FLUID FLOW IN RELATION TO DIESEL AND INTERNAL COMBUSTION ENGINE DESIGN

This book makes available in compact form the three lectures given in 1949 under the auspices of the Oil and Gas Power Division.

In the first of these lectures on Cooling of Spark-Ignition Engines, simplified analyses are presented of the heat transfer processes in spark-ignition engines which lead to concise correlation equations. The second paper, Fundamentals of Air Flow in Diesel Engine Manifolds, discusses the principles of fluid mechanics as applied to the fluid flow problems which exist in exhausting, scavenging and charging the Diesel engine, as well as certain aspects of the fluid flow problems that exist in some common designs. In the third article, consideration is given to the fundamental principles used in Reducing Engine Noise and their application to problems encountered in engine silencing researches.

$2.00—(20% discount to ASME Members)

Just Published—The 1949 ASME TRANSACTIONS

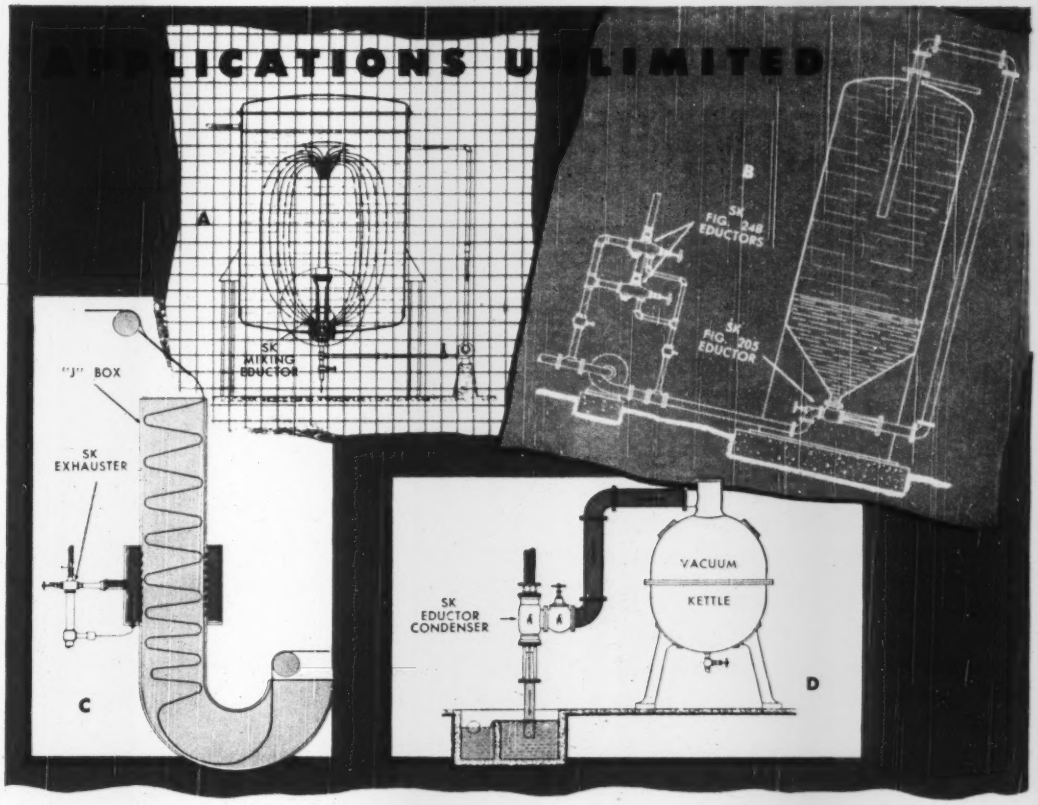
The 159 expertly written technical papers—the highly interesting and informative discussions—the carefully prepared bibliographies—the illustrations and data charts make this volume a treasure house of authentic information on major developments in the following branches of mechanical engineering:

Applied Mechanics
Aviation
Fluid Meters
Fuels
Gas-Turbine Power
Heat Transfer
Hydraulics
Industrial Instruments and Regulators
Lubrication
Machine Design
Metal Cutting
Metals Engineering
Oil and Gas Power
Petroleum
Production Engineering
Power
Railroad
Textile
Wood Industries

1400 Pages . . . Over 1500 Illustrations . . . Well Indexed . . . Cloth Binding

$15.00 to Nonmembers $7.50 to ASME Members

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
Publication-Sales Dept. 29 West 39th St., New York 18, N. Y.



A. Mixing two corrosive liquids in a tank quickly ruined mechanical agitators and bearings in a chemical plant. An SK Fig. 258 Liquid Mixing Eductor of corrosion-resistant material now gives thorough agitation with minimum maintenance.

B. In a large Eastern refinery, this deodorization process unit utilizes three SK Jets: two SK Fig. 248 Jet Eductors mix petroleum and oxygen for process, while an SK Fig. 205 Jet Eductor with regulating spindle mixes reaction slurry and liquid and pumps mix to top of reactor.

C. A textile industry "J" Box requires uniform heating and aeration of bleached cloth. An SK Steam Jet Exhauster entrains and mixes air and steam for uniform bleaching at a controlled temperature.

D. An SK Eductor Condenser is used in connection with a vacuum kettle in a food plant. An exceedingly simple arrangement, this installation reduced maintenance costs.

INGENIOUS engineers in all types of industry have convinced us, over the years, that the applications of SK Jet Apparatus are almost unlimited. The examples shown above are typical of a few of the problems our sales engineers have helped to solve. Other applications include pumping, mixing, blending, agitating, syphoning, scrubbing, compressing, exhausting, and many more.

As an organization offering an *engineering* as well as a *manufacturing* service, Schutte and Koerting has pioneered in the development of a wide variety of types, sizes, and constructions of Jet Apparatus. The results are a complete line of Jets for *standard* applications—and the problem-solving ability to build special equipment for *unusual* applications.

We invite you to tell us your problems involving *any* fluid medium—gases, liquids, slurries, or solid particles. Our broad experience in engineering, manufacturing, and applying Jet Apparatus may point the way to a profitable solution. Write for folder of SK Jet Apparatus catalogs.

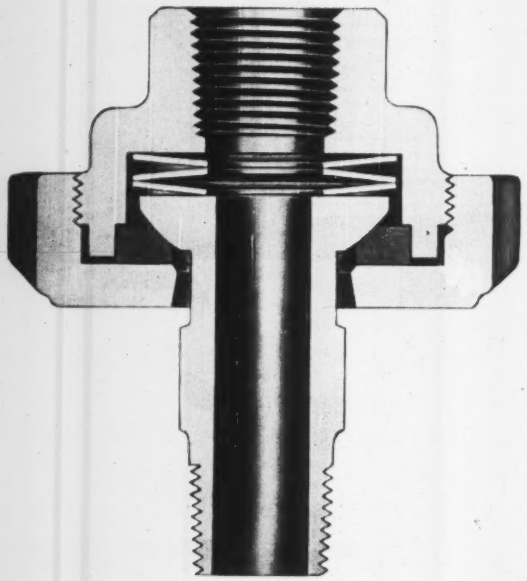
SCHUTTE and KOERTING Company

Manufacturing Engineers

1166 THOMPSON STREET • PHILADELPHIA 22, PA.

JET APPARATUS • HEAT TRANSFER EQUIPMENT • STRAINERS • CONDENSERS AND VACUUM PUMPS • OIL BURNING EQUIPMENT • ROTAMETERS • FLOW INDICATORS • RADIAFIN TUBES • VALVES • SPRAY NOZZLES AND ATOMIZERS • GEAR PUMPS • DESUPERHEATERS

Improved Barco Rotary Swivel Joints
FOR MINIMUM FRICTION



FRICTION-FREE PERFORMANCE WITH LOWER TURNING TORQUE. This compact, lightweight, low cost joint is especially efficient at high and low temperatures and pressures. It handles alternating steam and cold water without leakage. It is much more compact for the same capacity and has performed successfully on continuous rotation applications up to 30 RPM. This new, low torque joint will greatly reduce power costs and worker fatigue. It is practically maintenance free.

WIDE TEMPERATURE AND PRESSURE RANGES. The new Barco Rotary Swivel Joints withstand these extreme ranges with complete safety, no chance of bursting. Angular motion compensates for misalignment and there is no restricted internal diameter as in flexible hose.

• • •

Install these remarkable joints now. Our engineers will gladly discuss your problems. Sizes $\frac{3}{8}$", $\frac{1}{2}$", $\frac{3}{4}$", 1". When ordering, give complete information about pressures, temperatures, fluids or gases, and any other special conditions.

BARCO ***FLEXIBLE JOINTS***

Not just a swivel joint ...but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.

FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

"MOVE IN EVERY DIRECTION"

BARCO MANUFACTURING COMPANY,

1807 E. Winnemac Avenue, Chicago 40, Illinois • *In Canada:* THE HOLDEN CO., LTD., MONTREAL, CANADA

WHEN INSTALLING INSULATED PIPING

MAKESHIFT METHODS ARE NOT CHEAP

Makeshift or cut-fit-and-try methods are time-consuming and costly when applied to the field installation of either underground or exposed insulated piping.

The use of Ric-wiL Prefabricated Insulated Piping reduces this time and cost figure, producing worthwhile savings in installation costs. All Ric-wiL units, whether 21-foot straight-run sections or accessories such as elbows, tees, anchors and loops, are completely prefabricated to exact pre-installation engineering plans to insure fastest possible installation.

The high thermal efficiency and operating performance found in Ric-wiL systems are accomplished by exacting manufacturing standards and the use of the finest known insulating and corrosion-resistant materials. Forty years of experience in the insulated piping field are reflected in the high performance records of Ric-wiL systems in operation.

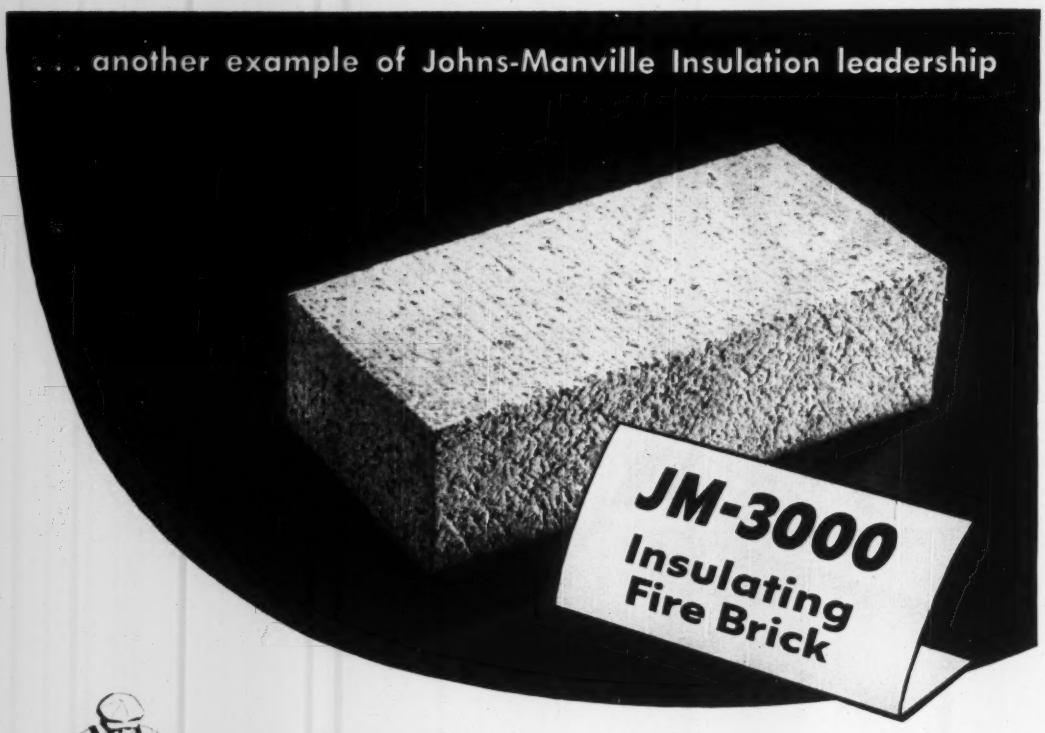
Call the Ric-wiL office nearest you and our representative will be glad to discuss your specific problem at your convenience.

For full technical information on Ric-wiL Insulated Piping Systems, call or write the Ric-wiL office nearest you or Dept. 14-P in Cleveland, Ohio.

RIC-WIL
INSULATED PIPING SYSTEMS
OVERHEAD THE RIC-WIL COMPANY · CLEVELAND, O. UNDERGROUND

FOR FORTY YEARS THE GREATEST NAME IN INSULATED PIPING SYSTEMS

. . . another example of Johns-Manville Insulation leadership



HERE IS A NEW insulating fire brick that truly deserves the spotlight.

It stands alone . . . for it is the only insulating fire brick made to withstand the intense heat of a full 3000F—and to *take* that temperature through long operating cycles. Important among its many advantages to industry are longer life, greater fuel savings and substantial savings in downtime.

Like other Johns-Manville Insulating Fire Brick, it too, is light in weight, has low conductivity and high heat resistance. J-M Insulating Fire Brick is equally efficient as back-up insulation, and as a direct refractory for furnaces, kilns and other types of high temperature equipment.

Back of this latest insulation achievement is Johns-Manville's 90 years of leadership in the development and manufacture of insulations; the largest and best-equipped insulation laboratory in the world, and a complete line of insulating materials in block, brick, cement and pipe insulation form for every temperature, and for every service condition.

Why not call a Johns-Manville Insulation Engineer about your next insulation job. Let his experience assure you the highest dividends on your insulation investment.

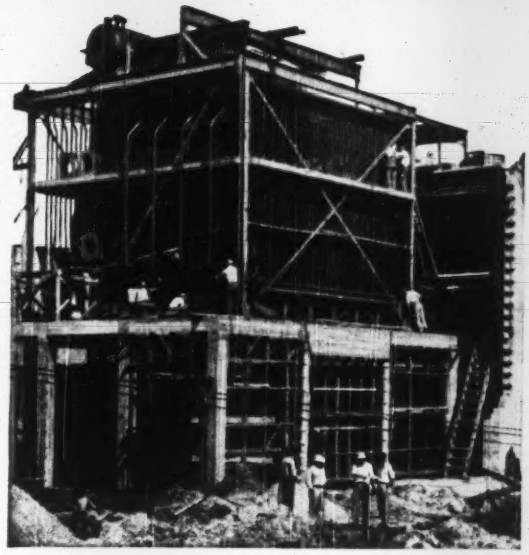
For further information, write Johns-Manville, Box 290, 22 E. 40th St., New York 16, N. Y.

JM PRODUCTS

Johns-Manville *First in* INSULATIONS

DOWELL

SPECIALISTS IN SCALE AND SLUDGE REMOVAL WITH CHEMICALS



Clean That New Boiler!

REMOVE MILL SCALE AFTER ERECTION— The Chemical Way!

WHEN you install a new boiler, you'll find it to your advantage to specify removal of the mill scale *after erection*, using Dowell Chemical Scale Removal Service. The Dowell method eliminates much of the extra care required in the handling of previously sand-blasted or pickled tubes—*and* many power engineers have found that the *chemical* removal of mill scale from new boilers before the first firing results in more satisfactory boiler operation.

Unless removed, mill scale may retard heat transfer, slough off particles which abrade the system during operation, and act as a base for further corrosion.

Dowell engineers are selected for ability, trained in field and laboratory, and backed by the experience of thousands of successful jobs. They use mobile pumping equipment to fill the new boiler with specially selected liquid solvents which can reach wherever steam and water flow. They bring with them all necessary mixers, heaters and control equipment to perform the cleaning operation.

Put Dowell Chemical *Mill Scale Removal* Service in your new boiler specifications! Call on Dowell also for estimates of the cost of cleaning your present boilers, condensers, heat exchange equipment, water lines and water wells.

DOWELL INCORPORATED · TULSA 3, OKLAHOMA

SUBSIDIARY OF THE DOW CHEMICAL COMPANY

CALL

New York 20
Boston 16
Philadelphia 2
Baltimore 18
Wilmington 99
Richmond 19
Jacksonville
Atlanta

Buffalo 2
Cleveland 13
Pittsburgh 19
Detroit 2
Chicago 2
St. Louis 8
Indianapolis
Louisville

Kansas City 8
Wichita 2
Oklahoma City 2
Houston 2
New Orleans 12
Baton Rouge
Ft. Worth 2
Shreveport 69

Mt. Pleasant, Mich.
Hamilton, Ohio
Charleston 27, W. Va.
Salem, Illinois
Borger, Texas
Wichita Falls, Texas
Lafayette, La.

Long Beach, Oakland, Casper: Dowell Associate-International Cementers, Inc.

DOWELL

A SERVICE ORGANIZATION

it's light...it's strong

it's the space-saving choice

FOR DRIVE AND CONVEYOR SERVICE

BALDWIN-REX DOUBLE PITCH ROLLER CHAIN!

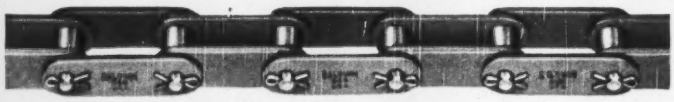
Light weight . . . strength . . . compactness, Baldwin-Rex Double Pitch Roller Chain combines all these important advantages for your drives and conveyors.

This economical chain is made of standard Baldwin-Rex roller chain round parts . . . pins, bushings, rollers ... but with plates that are double the pitch of corresponding standard roller chain. You get the same highly finished parts, the same basic advantages, the same long life and high strength of standard roller chain, all at a lower cost per foot.

Where your speeds are slow to medium . . . where centers are long or where space is limited, Baldwin-Rex Double Pitch Chain is your economical answer. In many applications, it can be used with cast tooth sprockets . . . an important cost-cutting advantage.

Baldwin-Rex Double Pitch Roller Chains are available in three basic styles as illustrated below. A wide variety of standard attachment links is available for these chains. For complete details, mail the coupon at right for your copy of Bulletin No. 49-3.

Baldwin-Rex Double Pitch Chain with Figure 8 Plates for drive service.

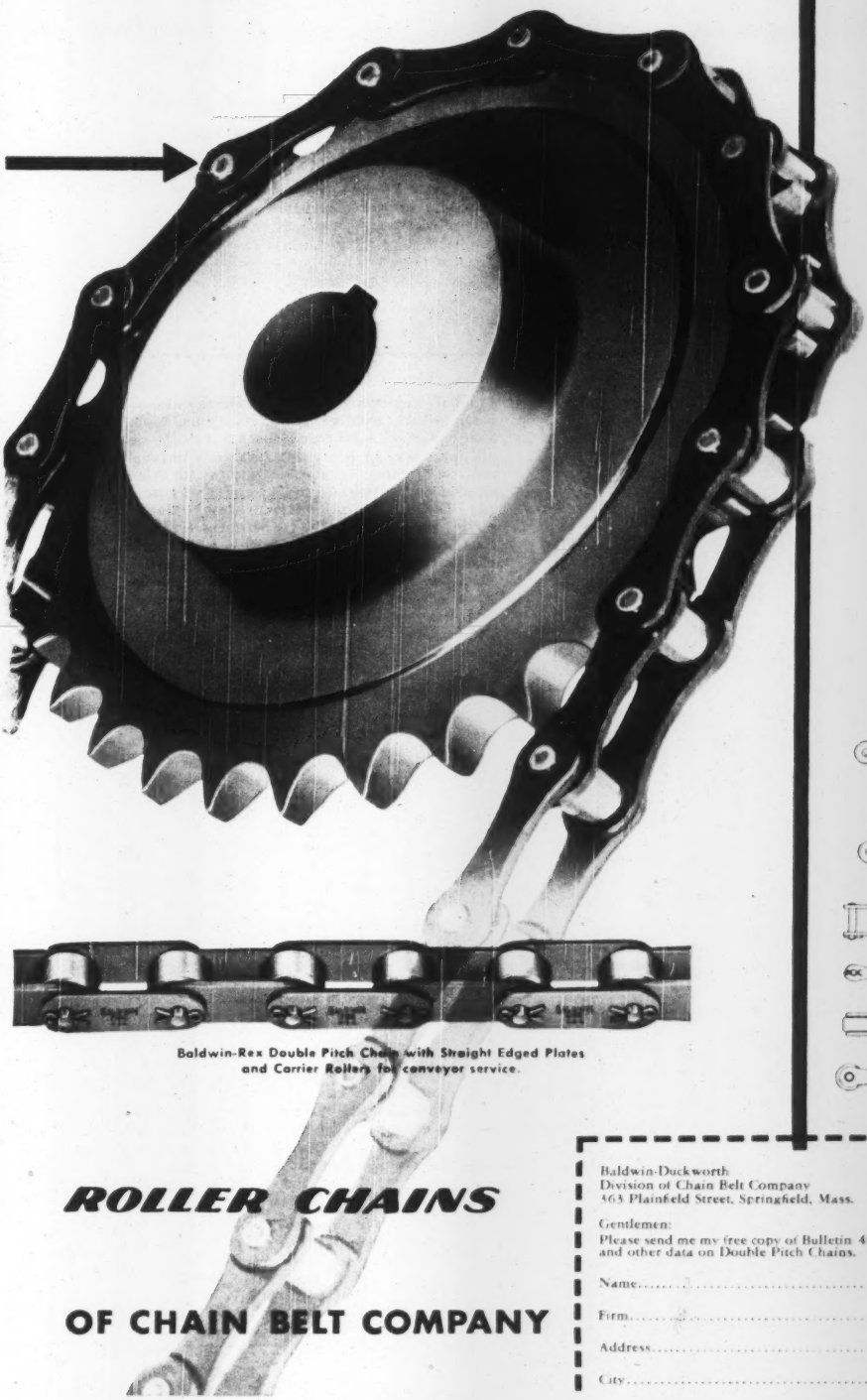


Baldwin-Rex Double Pitch Chain with Straight Edged Plates for conveyor service.

BALDWIN·REX

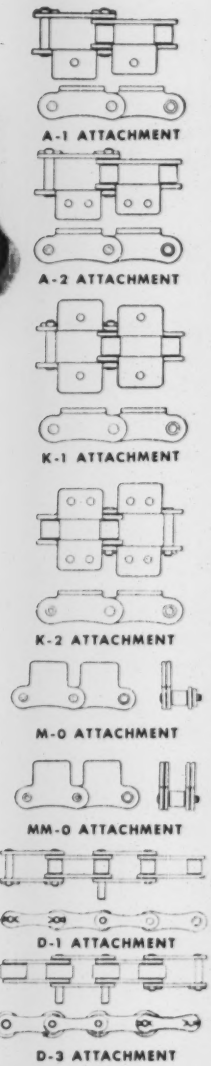
BALDWIN-DUCKWORTH DIVISION

a complete line from ¼ to 2½-inch pitch



Baldwin-Rex Double Pitch Chain with Straight Edged Plates and Carrier Rollers for conveyor service.

STANDARD ATTACHMENT LINKS



ROLLER CHAINS

OF CHAIN BELT COMPANY

Baldwin-Duckworth
Division of Chain Belt Company
363 Plainfield Street, Springfield, Mass.

Gentlemen:
Please send me my free copy of Bulletin 49-3 containing all the facts, prices and other data on Double Pitch Chains.

Name.....

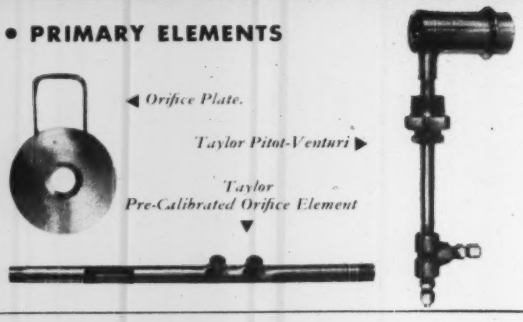
Firm.....

Address.....

City.....State.....

LET TAYLOR HANDLE YOUR FLOW PROBLEMS

• PRIMARY ELEMENTS



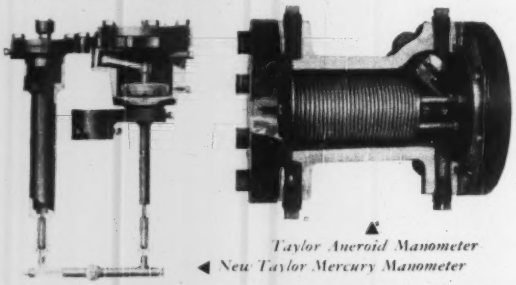
◀ *Orifice Plate.*

Taylor Pitot-Venturi ▶

Taylor Pre-Calibrated Orifice Element ▼

(1) Thin and thick type Orifice Plates from 2 to 24" in all standard materials. (2) Pre-Calibrated Orifice Assembly for high-accuracy with pipe sizes less than 2" are a "Specialty of the House" with Taylor. (3) The new and exclusive Taylor Pitot-Venturi Flow Element which produces greater differential with practically no pressure loss—7 to 10 times greater than by the conventional Pitot Tube. (4) Also standard Venturi Tubes. (5) Flow Nozzles from 3 to 14" in all standard materials.

• FOR MEASUREMENT

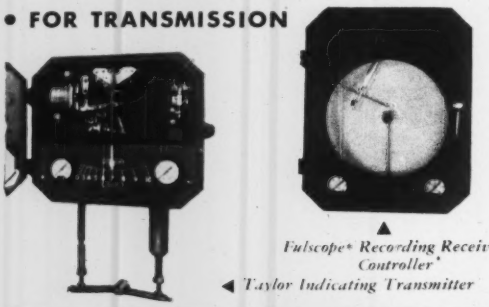


▲ *Taylor Aneroid Manometer*

◀ *New Taylor Mercury Manometer*

(1) New Taylor high-accuracy Mercury Manometer which features Teflon bearings, high energy output, submerged check valves, ½ of 1% accuracy, an adjustable leakless damping unit, and interchangeable range tubes for continuous ranges from 10 to 533 inches of water. (2) Taylor Aneroid (Mercury-less) Manometer, available in All-316 Stainless Steel or Cast Steel, accurately measures flow of hard-to-handle corrosive materials. No mercury to replace, no stuffing box. Sealing fluids or blow-back systems seldom needed. Long service. Easy cleaning. Easy range changes. Both Manometers available with Square Root Integrators.

• FOR TRANSMISSION



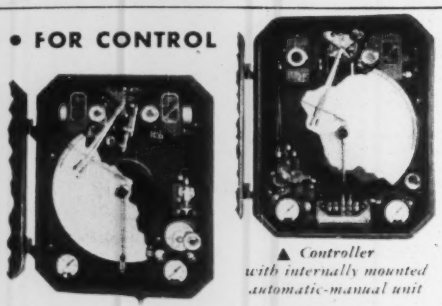
▲ *Fulscope* Recording Receiver Controller*

◀ *Taylor Indicating Transmitter*

Taylor Remote Transmission Systems accurately, quickly, economically, and safely transmit rate of flow to conveniently located point. Transmitters can be indicators, recorders or controllers. High accuracy—systems are calibrated to within ½ of 1% accuracy. High speed—only 2-second lag in 300 feet. Gives central control of widely distributed processes at one convenient point. Concentric dial transmitter with Mercury Manometer also available.

*Trade-Mark

• FOR CONTROL



▲ *Controller with internally mounted automatic-manual unit*

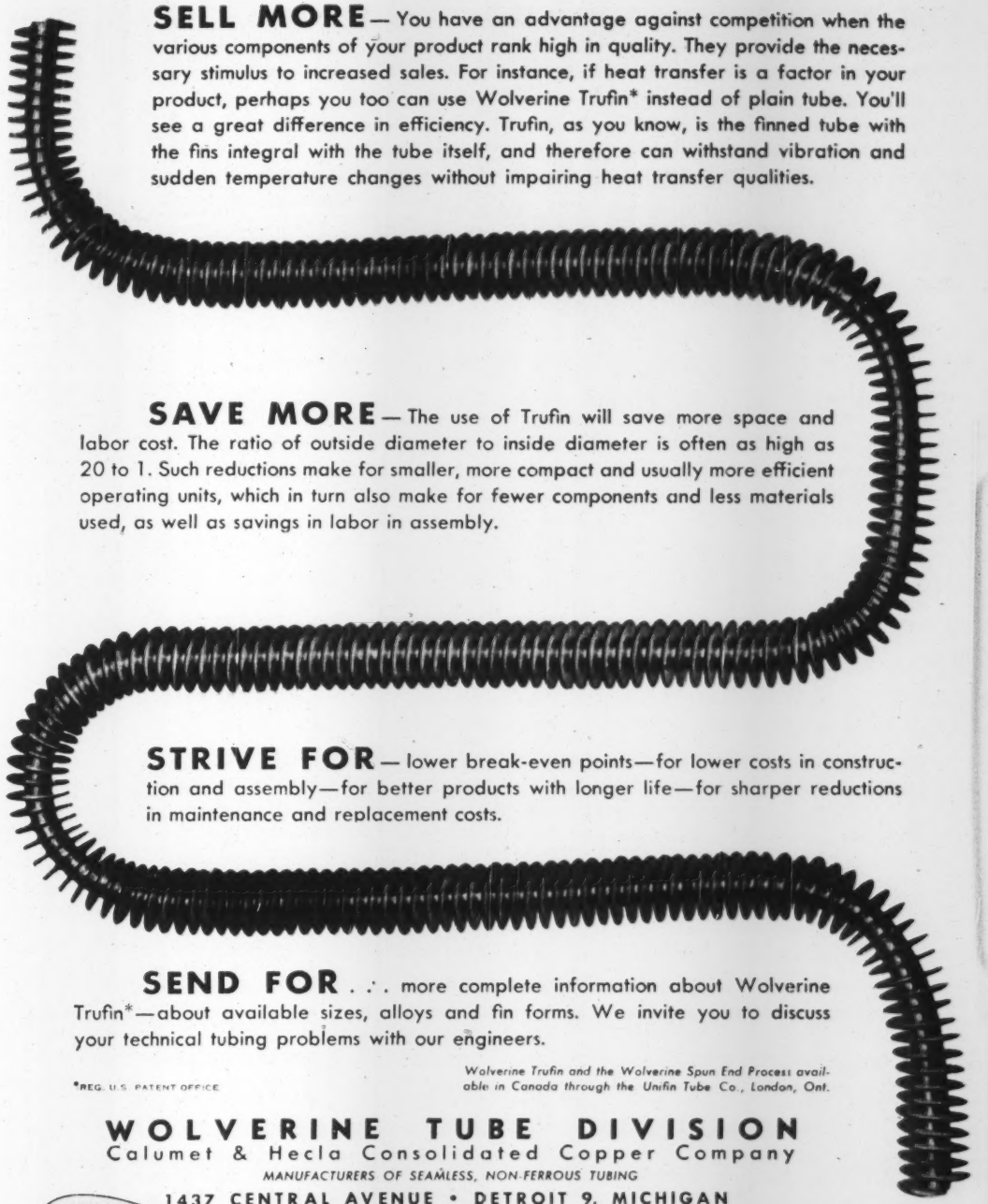
▲ *Fulscope Recording Pneumatic-Set Flow Controller*

Indicating or recording controllers in single or double duty form, with adjustable sensitivity or automatic reset. Ratio Flow Controllers with two Manometers attached. Control point may be adjusted by any other process variable. Pneumatic-set controllers whereby control point can be pneumatically adjusted from any remote location. Internally or externally mounted automatic to manual units.

• • •

For complete details, write for new Flow Catalog 98175, or ask your Taylor Field Engineer. He'll show you how Taylor Instrumentation can help you solve *any* flow problem. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

TAYLOR INSTRUMENTS MEAN ACCURACY FIRST



SELL MORE— You have an advantage against competition when the various components of your product rank high in quality. They provide the necessary stimulus to increased sales. For instance, if heat transfer is a factor in your product, perhaps you too can use Wolverine Trufin* instead of plain tube. You'll see a great difference in efficiency. Trufin, as you know, is the finned tube with the fins integral with the tube itself, and therefore can withstand vibration and sudden temperature changes without impairing heat transfer qualities.

SAVE MORE— The use of Trufin will save more space and labor cost. The ratio of outside diameter to inside diameter is often as high as 20 to 1. Such reductions make for smaller, more compact and usually more efficient operating units, which in turn also make for fewer components and less materials used, as well as savings in labor in assembly.

STRIVE FOR— lower break-even points—for lower costs in construction and assembly—for better products with longer life—for sharper reductions in maintenance and replacement costs.

SEND FOR . . . more complete information about Wolverine Trufin*—about available sizes, alloys and fin forms. We invite you to discuss your technical tubing problems with our engineers.

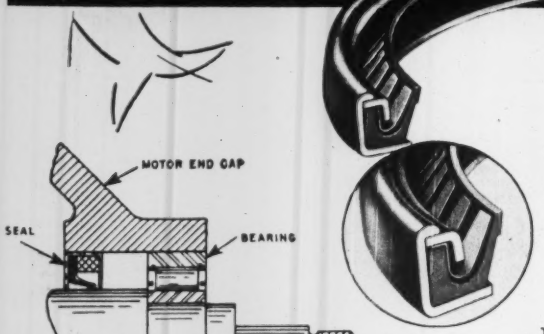
*REG. U.S. PATENT OFFICE

Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ont.

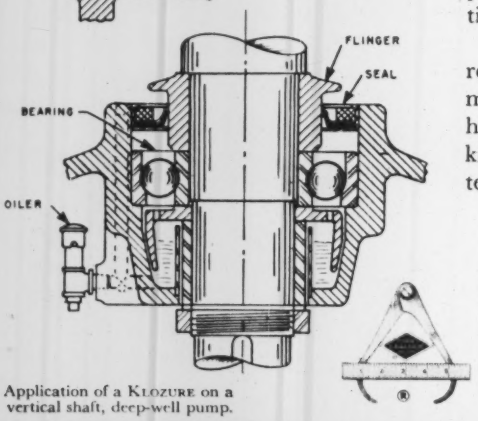
WOLVERINE TUBE DIVISION
Calumet & Hecla Consolidated Copper Company
MANUFACTURERS OF SEAMLESS, NON-FERROUS TUBING
1437 CENTRAL AVENUE • DETROIT 9, MICHIGAN

PLANTS IN DETROIT AND DECATUR, ALA.
Sales Offices in Principal Cities

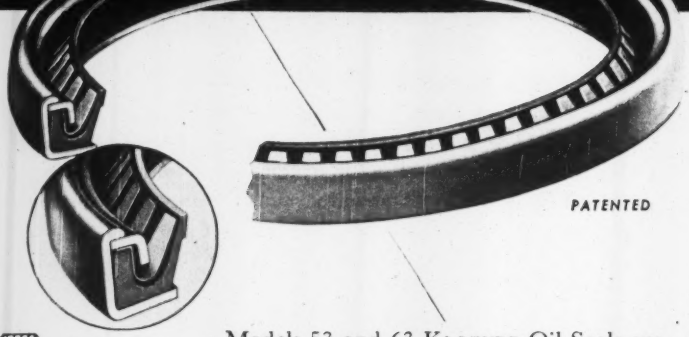
LIVE ACTION



Application of a KLOZURE Oil Seal on a motorized reducer.



Application of a KLOZURE on a vertical shaft, deep-well pump.



Models 53 and 63 KLOZURE Oil Seals are designed for "live action." They seal bearings effectively with minimum friction even on shafts having considerable whip or lateral movement, because of the light, uniform and positive spring pressure against the extremely flexible and sensitive sealing element.

For those applications for which none of our regular KLOZURE models is suitable we design and manufacture oil seals of many special types. If you have a bearing seal problem on any kind of equipment, let our experienced technical staff solve it for you.

Write for KLOZURE *catalog!*

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

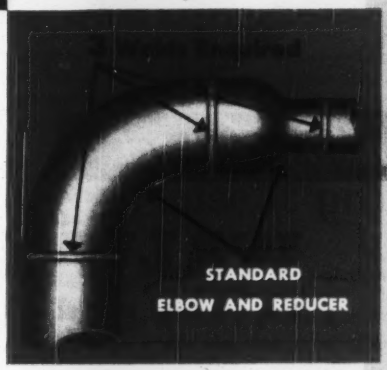
In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

GARLOCK *Klozure** OIL SEAL

* REG. U. S. PAT. OFF.

SAVE MONEY and get BETTER PIPING by using the MIDWEST REDUCING ELBOW

Instead of a Standard Elbow and a Reducer

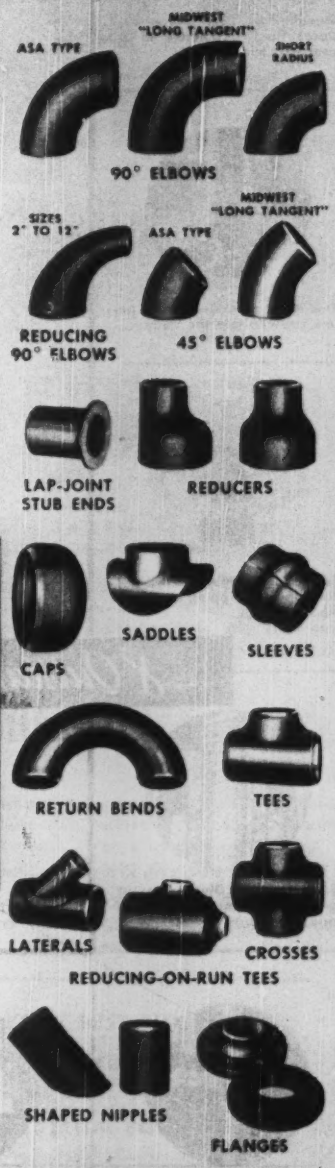


The Midwest Reducing Elbow saves more than a third of the welding when used instead of a standard elbow and reducer. In addition to a substantial saving in time and money, it provides much neater appearance and insulation is easier. The gradual reduction, smooth curve and absence of abrupt neck reduce the pressure drop and turbulence. Center-to-end dimensions are the same as for ASA standard elbows.

All the advantages of Midwest Standard Elbows are to be found in Midwest Reducing Elbows . . . unusual dimensional accuracy and uniformity, stress relieving, beneficial effect of working metal in compression, etc.

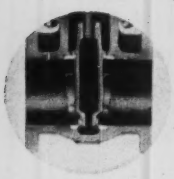
The Midwest Reducing Elbow is only one of many fittings developed by Midwest to reduce the cost and improve the quality of welded piping. You will find it advantageous to get in touch with the Midwest Distributor near you whenever you need welding fittings.

MIDWEST WELDING FITTINGS Improve Piping Designs and Reduce Costs

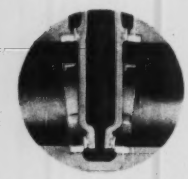


MIDWEST PIPING & SUPPLY COMPANY, Inc.

Main Offices: 1450 South Second Street, St. Louis (4), Mo.
***Sales Offices:* New York (7), 30 Church St.**
Chicago (3), 79 West Monroe St. • Los Angeles (33), 520 Anderson St. • Houston (2), 229 Shell Bldg. • Tulsa (3), 533 Mayo Bldg. • South Boston (27), 426 First St. • Distributors in Principal Cities.



Straight-Flow Port Design reduces fluid turbulence to a practical minimum.



Seat Rings of end-seated type are screwed into the body.

Sure-Grip Malleable Handwheel for non-skid gripping even with heavy gloves.

Brass Liner on Glands assures greater resistance to corrosion and scoring.

WALWORTH

iron body gate valves

with screwed or flanged ends

... 8 Outstanding Features

For complete information on these new Walworth Iron Body Valves, see your local Walworth distributor, or write for bulletin 106.

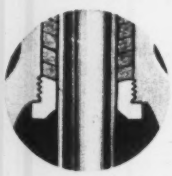
WALWORTH

valves and fittings

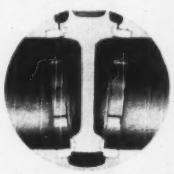
60 EAST 42nd STREET NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

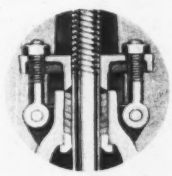
T-head Disc-to-Stem connection on OS&Y types provides stronger connection, prevents loosening of disc by corrosion.



Bronze Back-Seat Bushings in bonnets of OS&Y valves.



Solid Web Type Disc in OS&Y valves for greater strength and longer service.



Hinged Gland Eye-Bolts on OS&Y valves permit faster, easier repacking under full pressure.

American Blower—a time-honored name in air handling

In Chicago, as in other cities, American Blower Air Handling Products serve commerce, industry and public utilities. For air handling data in the Chicago area, call American Blower —Financial 6-2531. Elsewhere, consult your phone book.

Look before you buy. Comparison tests prove the superiority of American Blower Products. There's a big difference in quality, design, quietness, operating costs and efficiency between American Blower and other air handling equipment.

Air is free . . . use it profitably!

MODERN air handling equipment averages less than 4% of the total cost of a building.

Yet its use saves millions each year in many industries . . . actually adds millions to profits in others.

Building the finest equipment for handling air and putting air to profitable use has been American Blower's business since 1881.

Today, time-honored American Blower Air Handling Equipment is available for installation in industrial, commercial and public buildings, schools, stores and public utilities.

American Blower Equipment is universally recognized as having many plus advantages—in design, quality, lower operating costs and efficiency.

To buyers of American Blower Equipment, whether it be power plant equipment—mechanical draft fans, fly ash precipitators, Gyrol Fluid Drives for fan control and boiler feed pumps—or air handling equipment for any need—these plus values insure longer, more dependable service and lower operating costs.

Our nearest branch office will give you full data.

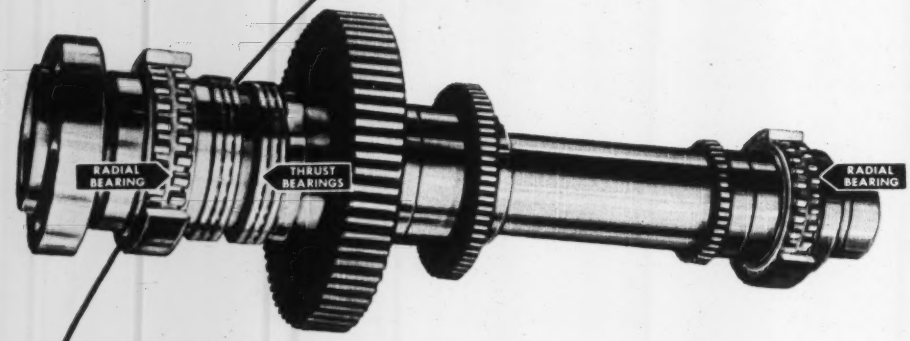
AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation

YOUR BEST BUY
AMERICAN BLOWER
AIR HANDLING EQUIPMENT

Serving home and industry
AMERICAN-STANDARD · AMERICAN BLOWER · CHURCH SEATS · DETROIT LUBRICATOR · KEWANEE BOILERS · ROSS HEATER · TONAWANDA IRON

when you want THIS →

. . . but get THIS →



. . . look into the SKF spindle design that provides from 100% to 500% GREATER SPINDLE RIGIDITY

When the going's hard and the cuts are heavy, here's how to say "Goodbye" to chatter. Equip your machine tools with the SKF Spindle which yields under load *as low as one fifth that of ordinary designs.*

RADIAL RIGIDITY IS PROVIDED BY THE DOUBLE ROW CYLINDRICAL ROLLER BEARINGS

Why?

Because the outer ring roller path offers no resistance to axial movement. Therefore, the outer ring is mounted with a press fit in the housing to increase rigidity.

Because a tight fit on the tapered spindle seat eliminates creep and gives rigid support to the inner ring.

Because internal clearance of the bearing is removed by expanding the tapered bore inner ring on the spindle.

Because the cylindrical rollers are lapped to closest tolerance, so that correct load distribution within the bearing is always assured.

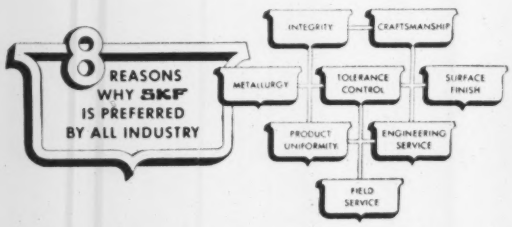
Because the roller paths are ground and honed.

Because the great number of rollers and their staggered arrangement insure efficient load distribution and virtual elimination of bridging effect.

AXIAL RIGIDITY IS PROVIDED BY THE BALL THRUST BEARINGS

SKF Catalog No. 272-A tells how this spindle design can be adapted to your particular requirements. SKF Industries, Inc., Phila. 32, Pa.

7041



SKF
BALL AND ROLLER BEARINGS

Pioneers of the Deep Groove Ball Bearing – Spherical Roller Bearing – Self-Aligning Ball Bearing

FORGINGS Offer So Many Sure Fire Ways to Obtain At The Point of Assembly

Macro-etch cross-section of Steering Lever forging shows how density of grain structure insures safety in operation of trucks and busses.

The maker of a Disc Clutch embodying this forged steel actuating lever increased the rate of machining two and one half times by having it forged.

A weight reduction of 22 per cent and a considerable saving in machining and finishing time was obtained by forging this Clutch Yoke used with an air-cooled gasoline engine.

This Sprocket forging weighs 18 lbs. less than the bar stock formerly required to produce it. Maker reports 40 per cent saving in machining and finishing time as result of forging to shape.

There are thousands of instances where forgings have reduced the cost of parts at the point of assembly. Forgings provide qualities and economies that are otherwise unobtainable. Forgings provide rapid assembly of complex parts by welding adaptability of widest range. Forgings permit reduction of dead weight because maximum strength and toughness are obtainable in lighter sectional thicknesses. Forging to shape avoids waste of metal and reduces machining and finishing time-cost. Forgings provide the strength and toughness for unrelenting and uninterrupted performance. The metal quality and cost-reducing possibilities obtainable in forgings cannot be duplicated. Recheck every stressed part in your equipment, as well as simple handles and levers, and consult a Forging Engineer about the possibilities for reducing parts' costs at the point of assembly. Only a Forging Engineer can inform you fully regarding the numerous advantages obtainable with forgings.

DROP FORGING ASSOCIATION

A REFERENCE BOOK ON **FORGINGS** FOR ALL USERS OF METAL PARTS

DROP FORGING *Topics* ISSUED 6 TIMES A YEAR

DROP FORGING ASSOCIATION
605 HANNA BUILDING • CLEVELAND 15, OHIO

☐ Booklet on "Metal Quality—How Hot Working Improves Properties of Metals"

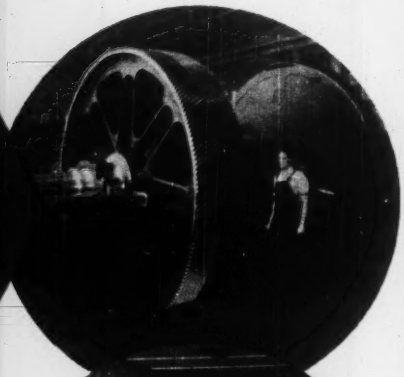
☐ "Drop Forging Topics" which presents numerous end use applications of forgings.

Name _____ Position _____

Company _____

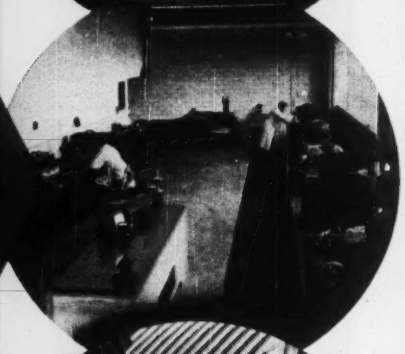
Address _____ City _____ State _____

UNIQUE FACILITIES



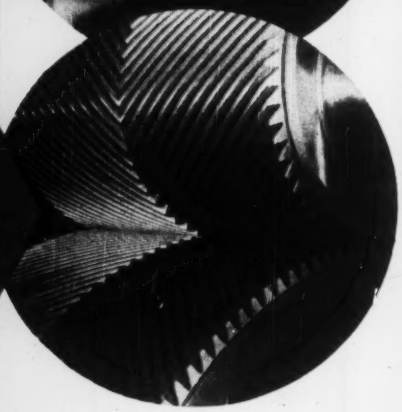
The famous *Gear with a Backbone* is made in the Buffalo plant of Farrel-Birmingham — a plant devoted to the design and manufacture of gears, gear units and gear generating machines. Here, seven of the largest gear generating machines in the world, plus numerous smaller ones, are used to cut continuous-tooth herringbone gears from "watch-fob" size up to twenty feet in diameter.

+ RESEARCH

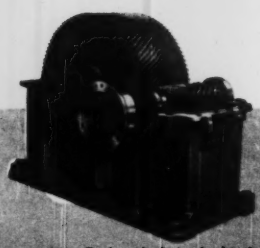


Advanced experimentation and exhaustive tests of gears are carried on in one of the most modern and fully equipped laboratories of its kind in the country.

= THE GEAR WITH A BACKBONE®



Because these gears have a *backbone*, instead of a useless center groove, the entire face width is put to work transmitting power. This provides extra strength and higher load-carrying capacity in smaller space — a definite advantage for many applications. Accuracy of tooth contour and tooth spacing, so vital to smooth, quiet operation, is inherent in the Farrel-Sykes method by which the teeth are generated.



FARREL® SPEED REDUCERS

Farrel speed reducers are available in a wide range of ratios and capacities. Designs include single, double and multiple reduction units; speed-change units; right-angle drives and drives to meet special requirements. The Gear with a Backbone, antifriction roller bearings, and heavy cases that prevent deflection and vibration are some of the features that insure maximum efficiency and smooth, quiet operation.

FB-564

When you have a gear problem, think of Farrel-Birmingham. Information and engineering assistance are available at any time, without obligation.

FARREL-BIRMINGHAM CO., INC. • 344 VULCAN ST., BUFFALO 7, N.Y.

Plants: Ansonia and Derby, Conn., Buffalo, N.Y.

Sales Offices: Ansonia, Buffalo, New York; Boston, Pittsburgh, Akron, Cleveland, Detroit, Chicago, Los Angeles, Tulsa, Houston

Farrel-Birmingham®

He's your biggest investment

improve your employee's efficiency for better production

G-E Industrial Electronics Training Course offers information on all phases of industrial electronics in twelve lessons, written and produced under the supervision of General Electric Industrial Electronic Specialists. A complete set of training material—instructor's manual, 10 sets of review books (12 to a set), 12 records, and 12 film slides cover such subjects as "Fundamentals of Electricity," "Photoelectric Relay Systems," "Grid Control of Electronic Tubes" and others. Simple explanations take away the mystery of electronic equipment, and enable trainees to understand circuits and diagrams quickly and easily. They will help you to better utilize the electronic equipment you now have or will get. As one user of the More Power to America program reports, "The course has been shown to engineers, and instrument and electrical craftsmen . . . created an interest in more information about electronic equipment, and where there is more knowledge there is more application."

NOW $150

It's a good buy . . . Fill in the coupon, attach your check, and send it to the nearest General Electric office or to the address on the coupon.

Extra sets of review books . . $3.00 ea.

Extra instructor's manuals . . . . . $3.00 ea.

APPARATUS DEPARTMENT
SECTION B, VISUAL EDUCATION DIVISION
GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

Enclosed is my check for $150.00 covering the cost of the Electronics Training Course. I understand this includes the entire kit containing records, slide films, review booklets, and instructor's guide.

NAME .....

COMPANY .....

STREET .....

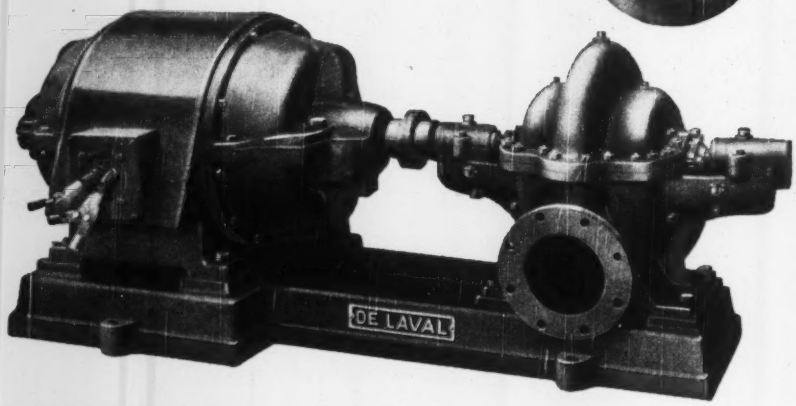
CITY ..... STATE .....

GENERAL ELECTRIC

685-15

every year the power savings grow greater

with DE LAVAL Labyrinth Wearing Rings



Here's the reason why

Assume that two pumps attain the same efficiency when new. One is equipped with ordinary close clearance, flat rings at the running joint between impeller and casing; the other with large clearance labyrinth rings.

As wear increases the clearance between the rings, the efficiency of the pump equipped with flat rings drops off more rapidly than that of the labyrinth ring pump because the flow retarding action of the flat rings depends solely upon the maintenance of close clearances; while the flow retarding action of the labyrinth rings is due to the resistance of a labyrinth passage.

The longer the pumps are used, the greater the difference in leakage, the greater the difference in efficiency and the greater the saving due to the use of De Laval labyrinth wearing rings. Every year the power savings grow greater

When selecting a pump consult the rating tables in De Laval Catalog 10-15-A.

DE LAVAL

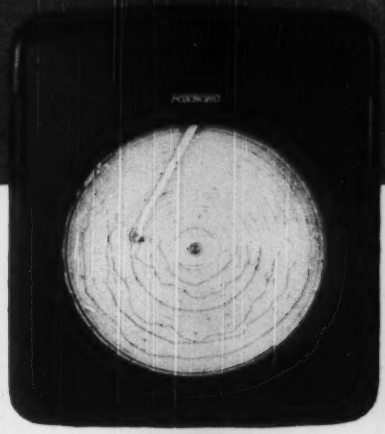
DE LAVAL STEAM TURBINE COMPANY, TRENTON 2, N. J.

TURBINES • HELICAL GEARS • CENTRIFUGAL BLOWERS AND COMPRESSORS
CENTRIFUGAL PUMPS • WORM GEAR SPEED REDUCERS • IMO OIL PUMPS

10-15

AT LAST! 6-Point Recording on a Single Round Chart

THE NEW MULTI-RECORD DYNALOG



Employing only one measuring system, the new Foxboro Multi-Record Dynalog gives up to 6 clean-cut records in as many different colors on one convenient *round* chart. The ingenious, foolproof switching arrangement provides recordings in sequence every 6 seconds—so close that the record of each measurement appears as a continuous line. The record colors positively will not run together.

Like all Dynalog Electronic Instruments, balancing from any measurement point is entirely *stepless* and continuous. Its combination of accuracy, speed and sensitivity is unequalled.

The Multi-Record Dynalog is available for measuring several temperatures or other process variables. Send for Bulletin 428. **The Foxboro Company, 182 Neponset Avenue, Foxboro, Mass., U. S. A.**

UNIQUE ADVANTAGES!

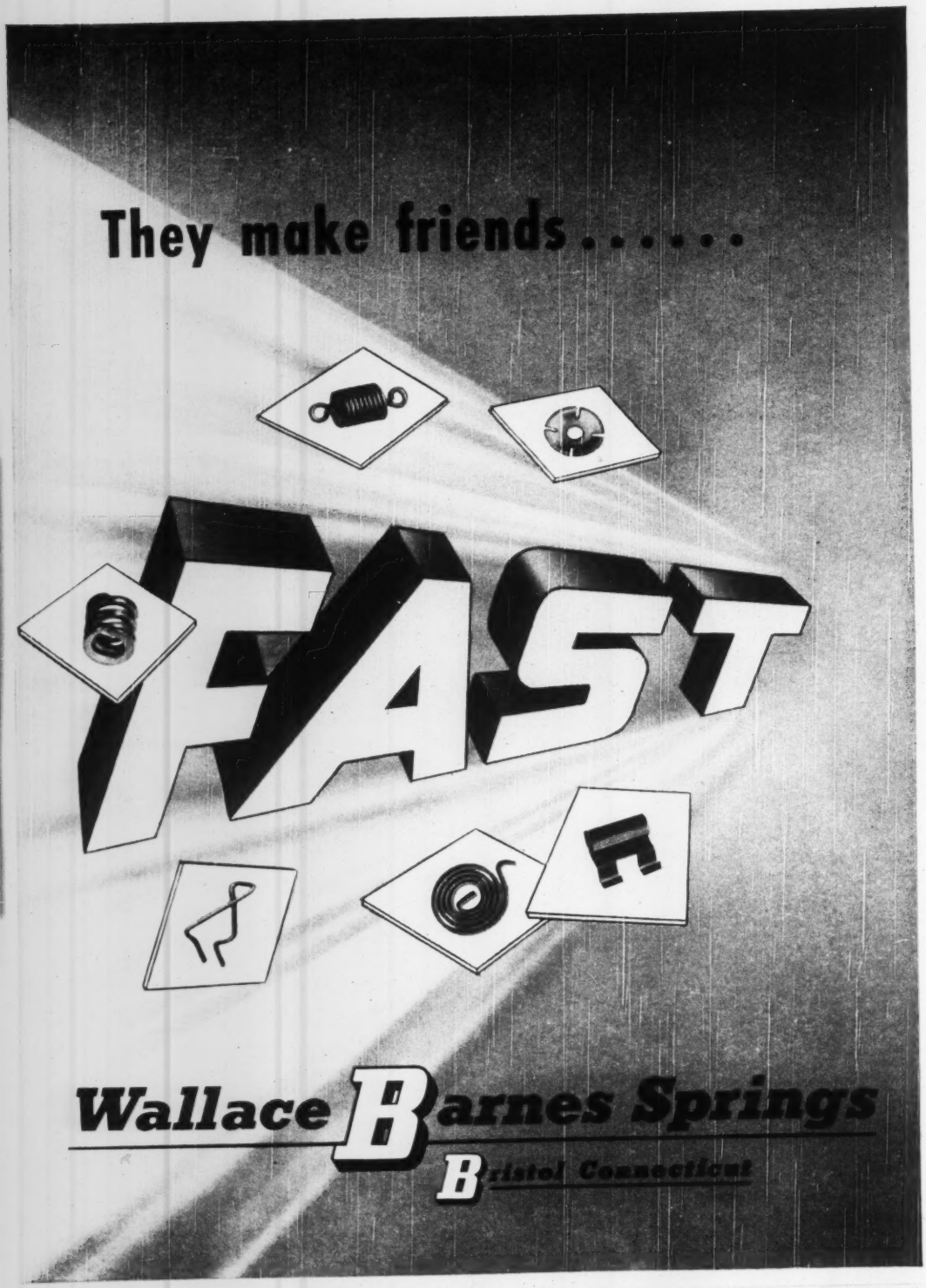
1. Round Chart simplifies operations. You can check records faster, easier and better on the familiar, compact round chart of the new Multi-Record Dynalog. No yards of paper to insert, remove and spread out. Practically continuous lines to follow. Up to 6 distinct colors. Charts occupy less space . . . cost less to use.

2. Round Chart standardizes operations. You can order, stock and use the identical form of chart as used on other types of process instruments.

3. Multi-Record Dynalog saves space.

Another FOXBORO FIRST

Reg. U. S. Pat. Off.


They make friends.....
FAST
Wallace Barnes Springs
Bristol Connecticut

VALVES ARE OPENED AND CLOSED *Automatically*..

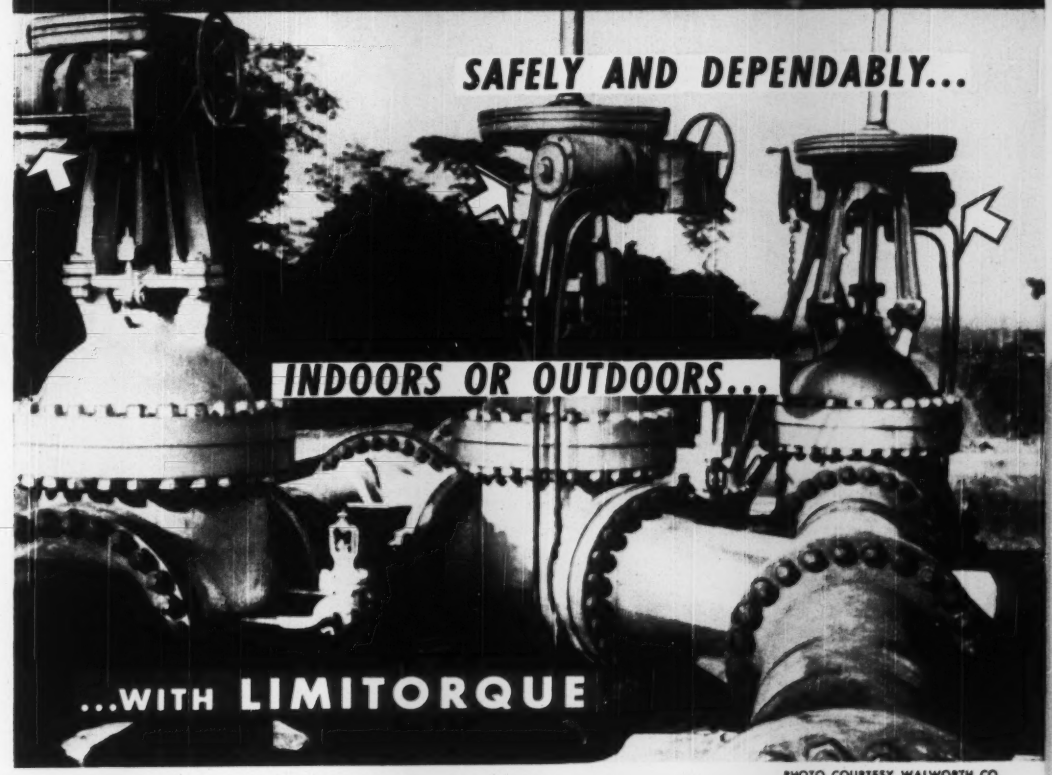


PHOTO COURTESY WALWORTH CO.

The above illustration was taken in far-off Venezuela, and shows 3 Electrically Operated *LimiTorque Valve Controls* mounted on 24" cast steel *Walworth* (series 300) *Valves*.

"LIMITORQUE" Operators are used on many pipe lines and in refineries throughout the world, because they operate (at the mere "push of a button") . . . under the most severe conditions of Heat or Cold, Rain, Snow, Dust, Dirt or Fumes . . . night and day . . . year-in and year-out—"LIMITORQUE" saves time, labor and money by *eliminating manual operation* of valves at distant locations. It opens and closes valves at the speed required, and is *absolutely dependable* and *safe*. As the name implies, "LIMITORQUE" limits the torque applied to valve operating parts and thus prevents damage to stems, discs and seats, etc.

"LIMITORQUE" utilizes any available power source for operation: electricity, oil, gas, water or air.

Please be sure to use your Business Letterhead when writing for this valuable 96-page illustrated Catalog.

Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

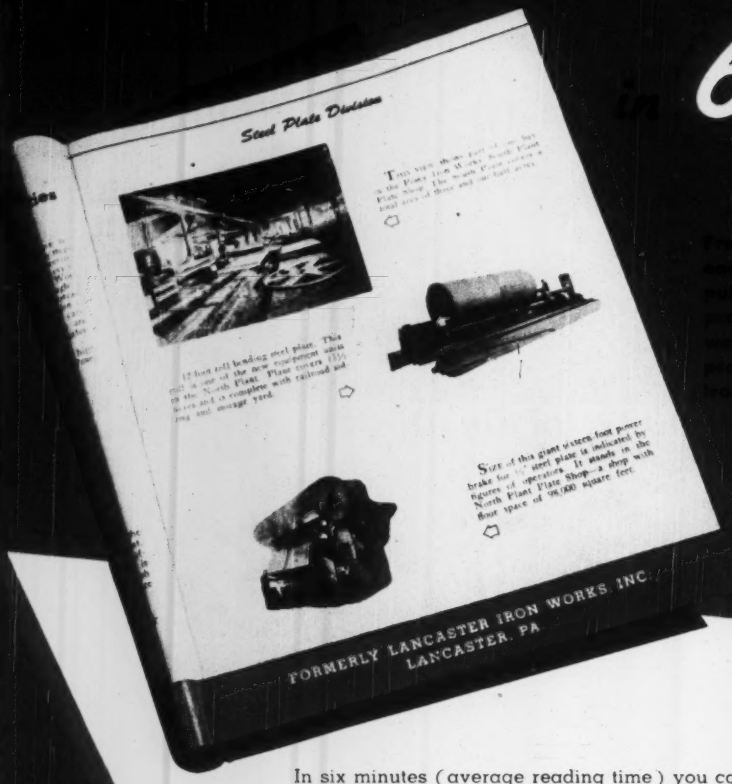
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON

IN CANADA: WILLIAM AND J. G. GREEY LIMITED, TORONTO

Industrial Gears and Speed Reducers — LimiTorque Valve Controls

How you may **CUT** steel plate construction **COSTS**

in 6 minutes



In six minutes (average reading time) you can review the Steel Plate section of Posey Iron's new 12-page reference bulletin. In those six minutes, you may learn of production facilities that can be used to cut your steel plate fabrication costs . . . products that may effect processing economies in your plant.

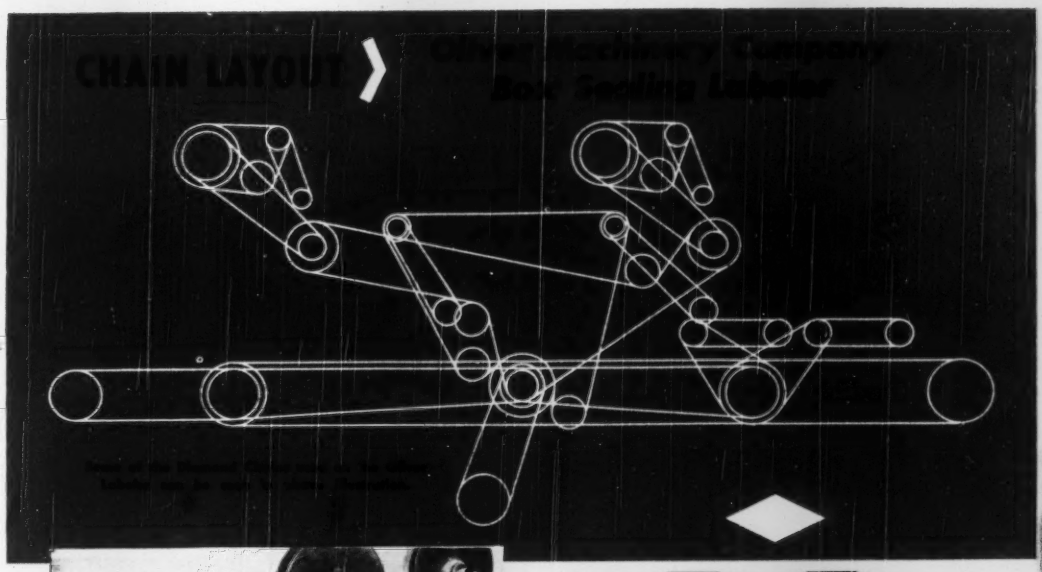
Among the "specialties" on which Posey Iron estimates are often low for work of high integrity you'll find elevated tanks . . . gas storage tanks . . . pipe (including dredge) . . . pressure vessels . . . stacks . . . stills . . . and digesters. Posey Iron is equipped to do the complete job from (1) design to (2) fabrication to (3) erection.

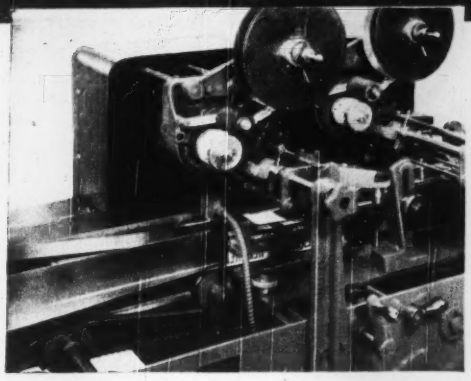
Write today for your free copy of Posey Iron's new bulletin. It may be your first move toward a greater reduction in steel plate construction costs than you had thought possible. No obligation.

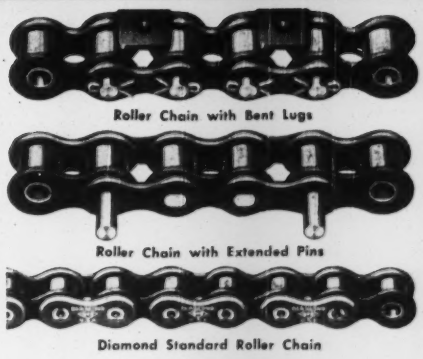
Established Since 1910

POSEY IRON WORKS, INC.

(Steel Plate Division)
formerly Lancaster Iron Works, Inc.
LANCASTER, PA.
New York Office: Graybar Building







28 SHAFTS – *Three Types of Diamond Chains*

HIGH OUTPUT AND ACCURACY MAINTAINED

● There are 28 widely separated shafts operated at various speeds and in clockwise and anti-clockwise directions on the Oliver Automatic Labeler.

Steady high output of automatic machinery is a necessity in this day of packaged products. Accuracy of timing, coordination of the various motions, and uninterrupted operation are secured through the use of Diamond Roller Chains.

If you use or build automatic machinery, you find it pays to insist on DIAMOND Roller Chains. Practical suggestions from our specialized engineering staff are yours for the asking. Write for Chain and Sprocket Catalog No. 709.

DIAMOND CHAIN COMPANY, Inc., Dept. 413, 402 Kentucky Ave., Indianapolis 7, Indiana. *Offices and Distributors in All Principal Cities.*

DIAMOND ROLLER CHAINS

SHOW...TELL...SELL

Your BEST BUYERS of Steam, Electrical and Mechanical Power Equipment

AT THE... 19th NATIONAL POWER SHOW

NATIONAL EXPOSITION OF POWER & MECHANICAL ENGINEERING

GRAND CENTRAL PALACE, N.Y.

NOV. 27 to DEC. 2

RESERVE YOUR SPACE NOW!

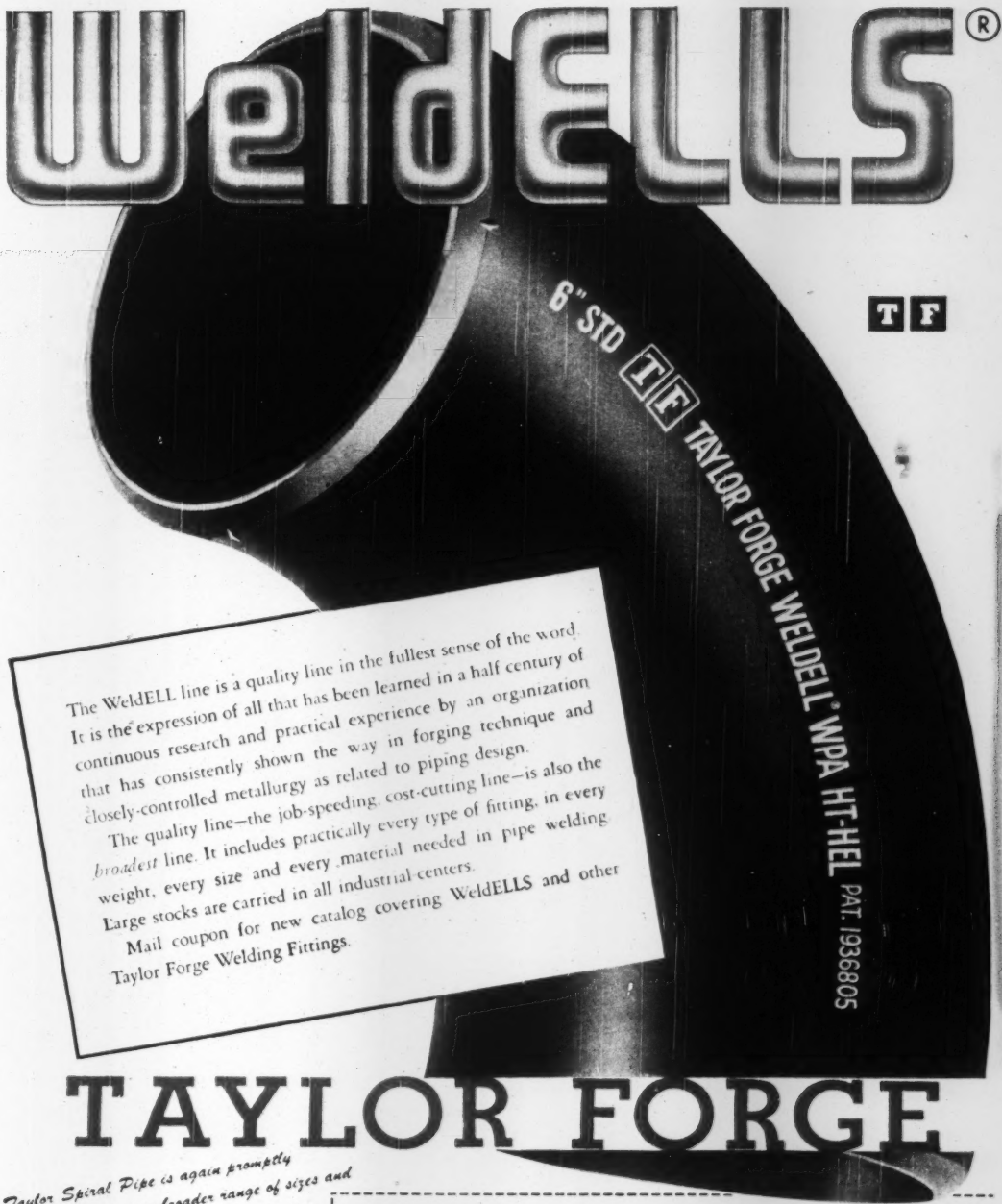
In the short period of 6 days, the Power Show brings you face to face with thousands of your best customers and prospects . . . in a receptive mind . . . away from business concerns . . . eager to learn new ways to keep costs down. Let them see first hand what your latest products look like . . . how they operate . . . why they're good buys. You can make no better investment in selling. So write now for space diagrams, rates and data. Get your application in early to assure a good location. Nearly 300 leading manufacturers have already engaged space at this important event.

Management International Exposition Co.
Grand Central Palace, New York 17, N. Y.

NOW UNDER AUSPICES OF A.S.M.E.

This foremost exposition of and for the power industry is being held for the first time under the auspices of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS and in conjunction with the Annual Meeting of the Society in New York City.

WeldELLS®



The WeldELL line is a quality line in the fullest sense of the word. It is the expression of all that has been learned in a half century of continuous research and practical experience by an organization that has consistently shown the way in forging technique and closely-controlled metallurgy as related to piping design.

The quality line—the job-speeding, cost-cutting line—is also the *broadest* line. It includes practically every type of fitting, in every weight, every size and every material needed in pipe welding. Large stocks are carried in all industrial centers.

Mail coupon for new catalog covering WeldELLS and other Taylor Forge Welding Fittings.

TAYLOR FORGE

Taylor Spiral Pipe is again promptly available in a broader range of sizes and thicknesses. Coupon brings pipe bulletin.

TAYLOR FORGE & PIPE WORKS
P. O. Box 485, Chicago 90, Illinois
Offices in all principal cities. *Eastern Plant:* Carnegie, Pa. *Western Plant:* Fontana, Calif.

☐ Please send new Catalog 484 covering welding fittings and forged steel flanges.
☐ Send new Bulletin 493 covering Taylor Spiral Pipe and related fittings.

NAME
POSITION
COMPANY
STREET ADDRESS
CITY ZONE STATE

504-0450 Mail to Taylor Forge & Pipe Works, P. O. Box 485, Chicago 90, Ill.

KUNKLE SAFETY AND RELIEF VALVES

UP TO
50% MORE
RELIEVING
***CAPACITY PER SIZE**

** N.B. Certified for A.S.M.E.*

Kunkle steam air and gas safety and relief valves lower your costs with increased capacity per size. Get this Kunkle bonus. Specify Kunkle Valves.

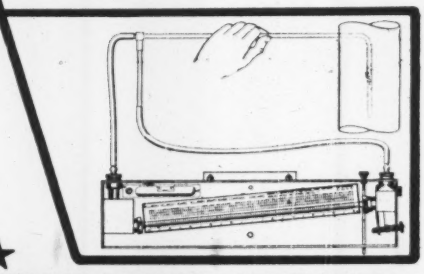
Bronze, iron and steel. Wide range of pressures and temperatures.

Write for Catalog and Capacity Data Covering Standard Items. Send Specifications and Inquiries For Special Assemblies to:

KUNKLE VALVE CO.
115 SO. CLINTON ST.
FORT WAYNE 2, INDIANA

BE SURE ABOUT *Air Velocities* WITH AN ELLISON PITOT TUBE

Power plant engineers, and heating, ventilating and dust control contractors can quickly measure drafts or air and gas flow velocities with an Ellison Pitot Tube. Used in combination with Ellison Portable Inclined Draft Gage. Readings in feet per minute. Send for complete Treatise —Bulletin F.



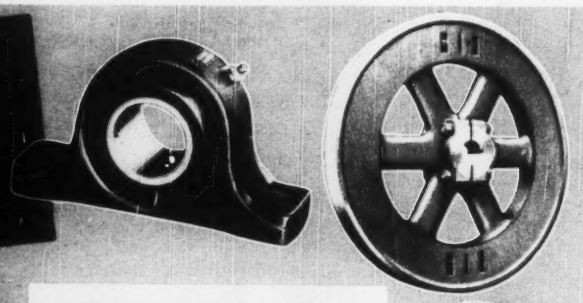
★

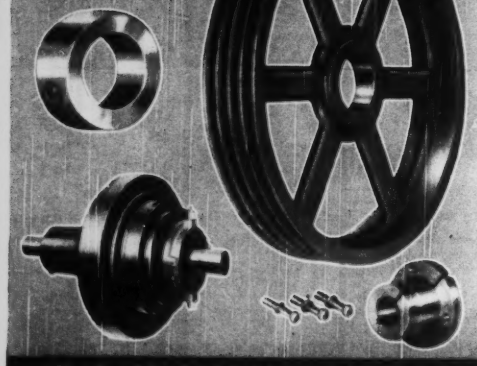
ELLISON DRAFT GAGE CO.

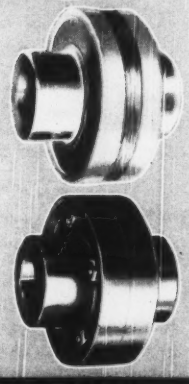
214 W. KINZIE ST. Since 1896 CHICAGO 10, ILL.

THE ELLISON LINE ALSO INCLUDES:
Dial Draft Gages—Bell Type · Inclined Draft Gages—Portable Inclined Vertical Tube Gages · Vertical Tube Gages—Oil, Heavy Liquid and Mercury—Single and Multi-Tube · Saturator Gages U Gages—Stationary and Portable · Air Filter Gages—Dial and Inclined Tube Types · Pilot Tubes · U Path Steam Calorimeters Portable Gas Analyzers—Orsat Type

A Complete line of TRANSMISSION EQUIPMENT







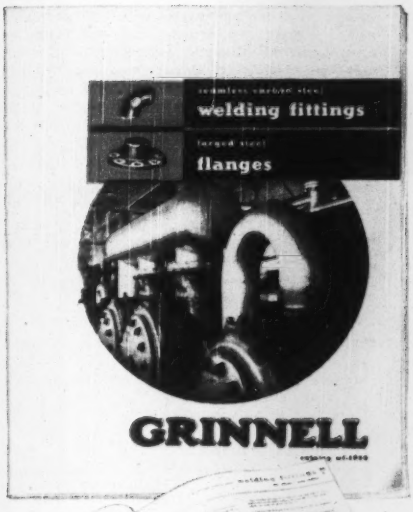
Wood's Modern Equipment for the Mechanical Transmission of Power is, today, one of the most complete lines offered by any manufacturer. It embraces not only the standard line of Shafting, Couplings, Collars, Pulleys, V-Belts, V-Belt and Rope Sheaves, Hangers, Pillow Blocks and Friction Clutches, but a wide range of special items built to order for specific applications. Write for full information.

Power Transmission Equipment Engineers and Manufacturers since 1857.

T. B. WOOD'S SONS COMPANY, CHAMBERSBURG, PENNA.

Yours for the asking
NEW CATALOG
with
complete information

Grinnell welding fittings and forged steel flanges



Write today for your copy of the entirely new Grinnell Welding Fittings Catalog.

Table of Contents

SEAMLESS CARBON STEEL BUTT WELDING FITTINGS

90° elbows . . . long radius, short radius, light gauge, special wall thicknesses
45° elbows . . . long radius, light gauge, special wall thicknesses
180° returns . . . long radius, extra long radius, short radius, light gauge, special wall thicknesses
tees . . . straight, reducing
crosses
reducers
laterals
lap joint stub ends
caps
saddles
backing rings
dimensional tolerances

FORGED STEEL FLANGES

welding neck . . . 150 to 2500 lbs.
slip-on . . . 150 to 2500 lbs.
lap-joint . . . 150 to 2500 lbs.
threaded . . . 150 to 2500 lbs.
blind . . . 150 to 2500 lbs.
socket type . . . 150, 300, 600 lbs.
reducing . . . threaded and slip-on 150 to 2500 lbs.
orifice . . . slip-on; welding neck; welding neck, ring joint; threaded 300 to 1500 lbs.
flange extras
dimensional tolerances
minimum finished bores
flange facings
facing dimensions of ring joint flanges
thread standards and threading practice
service pressure ratings
physical and chemical requirements

GRINNELL

Grinnell Company, Inc., Providence 1, R.I. Warehouses: Atlanta • Buffalo • Charlotte • Chicago • Cleveland • Cranston • Fresno • Kansas City • Houston • Long Beach Los Angeles • Milwaukee • Minneapolis • New York • Oakland • Philadelphia • Pocatello • Sacramento • St. Louis • St. Paul • San Francisco • Seattle • Spokane

Here's why

TRU-LAY PUSH-PULL

is a valuable aid in machine design

TRU-LAY Push-Pull is precision-made. Therefore it . . .

. . . is positive in action as a steel rod, yet flexible as wire rope

. . . transmits action over long or short lengths, with few or many bends

. . . will operate while flexing, with practically no lost motion

. . . is made in capacities up to 1000 pounds input

. . . is designed for long life—a machine part—not a flimsy gadget

MAIL THE COUPON BELOW

(to our Detroit Office) for bulletin of information about TRU-LAY Push-Pull.

6-235 General Motors Bldg., Detroit 2

1119 Santa Fe Avenue, Los Angeles 21

Bridgeport, Conn.

ACCO

AUTOMOTIVE AND AIRCRAFT DIVISION
AMERICAN CHAIN & CABLE

Please send me copy of descriptive bulletin DH-87-M-1.

Name_____

Company Name_____

Address_____

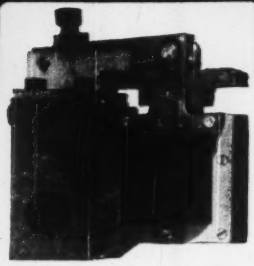
City_____ Zone____ State_____

NEW HIGH PRESSURE

SOLENOID VALVES

Features

- Rugged compact construction
- 3000 P.S.I. operating pressure
- Continuous duty
- Poppet design eliminates leakage
- May be mounted in any position
- Impregnated coils resist moisture



FOR 110-VOLT 60 CYCLE A.C. CURRENT

Waterman High Pressure Solenoid Valves are inexpensive compact units designed for continuous duty in hydraulic systems where pressures are as high as 3000 P.S.I. Poppet type construction gives positive sealing against internal leakage. Impregnated oil resistant coils make these valves suitable for mounting in oil reservoirs. In many cases this feature eliminates costly piping and makes possible the construction of smaller more compact hydraulic power units. Available in $\frac{3}{8}$" pipe size. Electrical requirements are 110 volt—60 cycle A.C. current.

West Coast: 918 No. Kenilworth Ave., Glendale 2, Calif.

WATERMAN ENGINEERING Company

721 CUSTER AVENUE
EVANSTON, ILLINOIS

Use a Classified Advertisement in

MECHANICAL ENGINEERING

for quick results

REPRESENTATIVES AVAILABLE REPRESENTATION WANTED
BUSINESS OPPORTUNITIES MANUFACTURING FACILITIES
EQUIPMENT FOR SALE or WANTED PATENT ATTORNEYS
HELP WANTED POSITIONS WANTED
EMPLOYMENT AGENCIES AND SERVICE BUREAUS

If you desire capital or have it to invest; if you have a patent for sale or development; if you have on hand used machinery for disposal, or if you want such equipment; if you have copies of publications, or a set of drawing instruments to dispose of; if you need help or want a position, in fact, anything to be offered that somebody else may want, or anything wanted that somebody else may have—*use a classified advertisement in the Opportunities Section.*

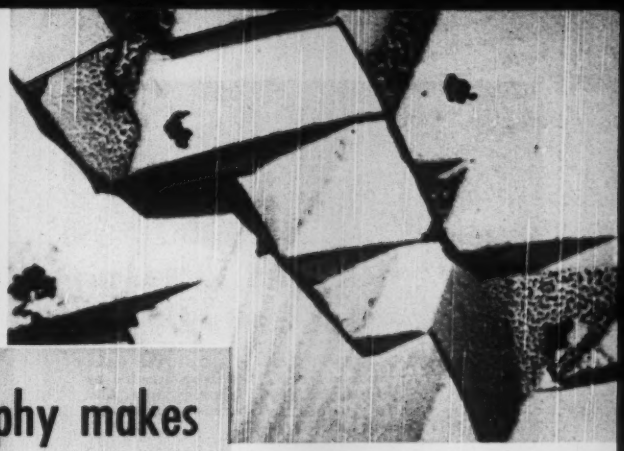
RATES

Classified advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $1.25 a line, $1.00 a line to members of A.S.M.E. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 3 line basis. Display matter carried in single column units of multiples of one inch at the flat rate of $20 per inch per insertion. Copy must reach us not later than the 10th of the month preceding date of publication.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 West 39th Street, New York, N. Y.

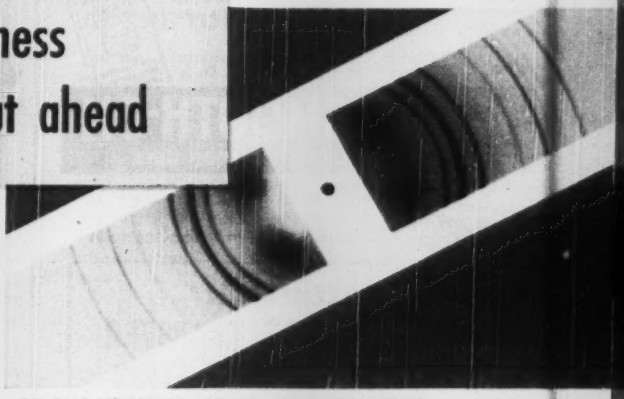
DISPLAYS MASSIVE PRODUCTS—A Diesel locomotive can roar across the Rockies—all on a movie screen in a prospect's office. All because photography can take huge things or small, and make them of a size for a salesman, teacher, or demonstrator to show.

Photography makes big things small—small things big—and business comes out ahead



MAKES MICROSCOPIC DETAILS CLEAR—Photography takes great magnifications produced by the electron microscope (20,000X) on fine-grain Kodak plates, enlarges and records them up to 100,000X on Kodak projection papers. Previously undetectable details and new facts are revealed.

REDUCES FILING SPACE BY 98%—With microfilming, bulky records can be reduced and stored on a few rolls of film. 675 drawings, 24" x 36", can be recorded on a 100' roll of 35mm. Recordak or Kodagraph Micro-File Film. And everything is quickly ready for reference in the Recordak or Kodagraph Film Reader.



REVEALS STRUCTURE AND CONDITION OF METALS—X-ray diffraction patterns on Kodak films or plates provide important information concerning the crystal structure of metals. These patterns help show how alloys can be improved or new alloys made—give data on the effect of machining, drilling, and punching upon the structure of the material.

WITH THE SPEED of a flick of light, photography can reduce or enlarge accurately to scale, and without missing the tiniest detail. And that's not all.

It can magnify time with the high speed motion-picture camera so that the fastest motion can be slowed down for study. It can record the penetrating x-ray and reveal internal conditions of materials and products. With movies and stills, it can repeat a story, time and again, without the loss of a single detail.

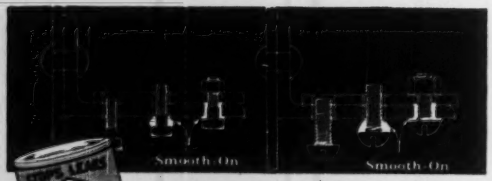
Yes, photography serves business and industry in many important and valuable ways. It can work for you, too. If you would like to know how, please feel free to write for literature, or for specific information which could be helpful to you. Eastman Kodak Company, Rochester 4, New York.

FUNCTIONAL PHOTOGRAPHY

serves industrial, commercial, and scientific progress

Kodak

TRADE-MARK



Holes Not Threaded-But Bolts *Hold*

With Smooth-On No. 1 Iron Cement you can make bolts, studs or machine screws hold in unthreaded or oversize holes. You thus save time, labor, expense. And the parts stay tightly together, because Smooth-On expands slightly in hardening.

Use Smooth-On No. 1 for bigger repairs, too. Seal cracked casings of pumps, valves, condensers, etc., with it. Stop leaks in pipe lines, tanks, radiators. Tighten loose parts and fixtures all over the plant. Get Smooth-On No. 1 in 7 oz., 1 lb., 20 lb. or 100 lb. sizes. If your supply house hasn't it, write us. SO-315

FREE REPAIR HANDBOOK

40 pages describing Smooth-On repairs that can save you time and money. 170 illustrations. Write for YOUR free copy now.

Smooth-On Mfg. Co., Dept. 56,
570 Communipaw Ave., Jersey City 4, N. J.

Do it with **SMOOTH-ON**
THE IRON CEMENT OF 1000 USES

Explains principles *and* applications

ELEMENTS of HEAT TRANSFER and INSULATION

Second Edition

By MAX JAKOB, *Illinois Institute of Technology* and GEORGE A. HAWKINS, *Purdue University*

JUST PUBLISHED. Includes several new practical applications and additional tables and graphs. Several sections have been completely revised and the chapter on radiation has been greatly expanded to make ample use of Hottel's results in geometry of radiation. Eleven new sections cover such subjects as graphical and numerical methods for analyzing conduction problems, and heat transfer and fluid friction on plane surfaces.

April 1950 · 230 pages $4.00

EXAMINE BOOK FOR 10 DAYS

ON APPROVAL COUPON

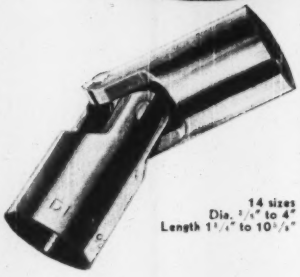
JOHN WILEY & SONS, INC., Dept. ME-4-50
440 Fourth Ave., New York 16, N. Y.

Please send me, on 10 days' approval, a copy of Jakob & Hawkins' ELEMENTS OF HEAT TRANSFER AND INSULATION. If I decide to keep the book, I will remit $4.00 plus postage; otherwise I will return the book postpaid.

Name .....
Address .....
City ..... Zone ..... State .....
(Offer not valid outside U.S.)

It takes special equipment to achieve such perfection as you find only in...

LOVEJOY UNIVERSAL JOINTS



14 sizes
Dia. 3/4" to 4"
Length 1 1/4" to 10 3/8"

Even drilling a Lovejoy Universal joint requires special machines of super-accuracy.

Save expense—gain longest, trouble-free service with Lovejoy *Universal* joints!

In Lovejoy joints high quality heat-treated alloy steel is fabricated to concentricity guaranteed to .0005, with grinding to infinite accuracy.

Rivets are microscopically flush with body. Permit working inside tubing, or in close quarters.

Special profiling around forks gives maximum bearing surface under cut for greatest angle of operation without sacrificing strength. No binding, backlash or endplay.

Send for illustrated descriptive literature and prices on any quantity, small or large.

DELIVERIES FROM STOCK

This dynamometer for testing Lovejoy joints was exclusively designed to insure greatest possible precision. It checks and double-checks.

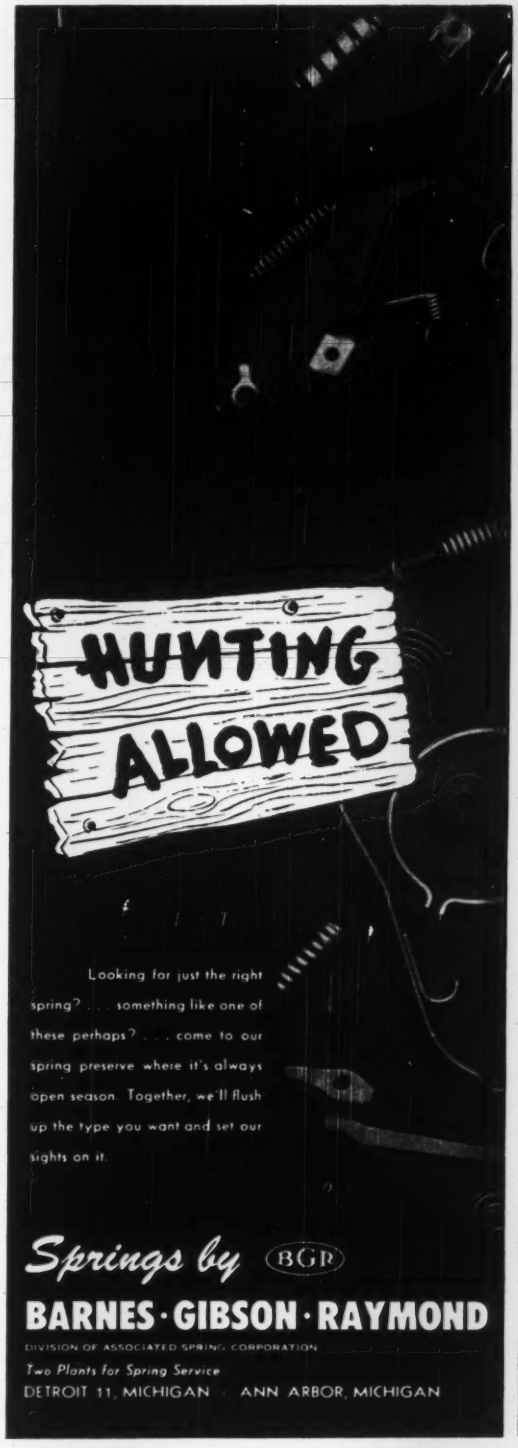
Specially designed grinding machines turn out Lovejoy joints with mirror-like surfaces, finished to split-thousandths degree accuracy.

Final inspection assures the same perfect functioning of every Lovejoy joint, regardless of quantity purchased.

LOVEJOY 50 CHICAGO

LOVEJOY FLEXIBLE COUPLING CO.
5032 W. LAKE ST.
CHICAGO 44, ILLINOIS

Also mfrs. Lovejoy Flexible Couplings, and Lovejoy Variable Speed Transmissions.



Looking for just the right spring? . . . something like one of these perhaps? . . . come to our spring preserve where it's always open season. Together, we'll flush up the type you want and set our sights on it.

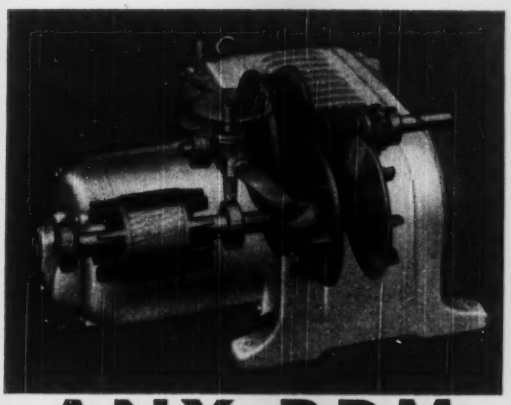
Springs by BGR

BARNES · GIBSON · RAYMOND

DIVISION OF ASSOCIATED SPRING CORPORATION

Two Plants for Spring Service

DETROIT 11, MICHIGAN — ANN ARBOR, MICHIGAN



ANY RPM

THOUSANDS of SPEEDS

AT THE TOUCH of YOUR HAND

You can diminish or increase the speed of your machines to the exact rpm required for top production by installing the U. S. Varidrive Motor. It's the original all-in-one unit that eliminates cone pulleys, gear-changing contraptions or extraneous speed changers. A convenient control handle is operated for instant change from speed to speed. You'll get more production and synchronize the speed to the operator's ability. The improved U. S. Varidrive embodies the new Autotaut belt tensioner which counterbalances varying loads so that no slippage occurs.

U. S. VARIDRIVE MOTOR

1 TO 10,000 RPM **¼ TO 50 HP**

When you use a U. S. Varidrive you can count on the full rated horsepower at the power take-off shaft. There are countless applications for the Varidrive. It regulates speed of machinery to compensate for variation in workers' abilities; permits quick change to give the right speed for different types of work in production; it adjusts speeds to compensate for changes in viscosity, temperature, humidity or quantity, etc. Think of the numerous applications in your plant where variable speed will increase production efficiency—then apply Varidrives.

A tip to the very wise—buy Varidrives

U.S. ELECTRICAL MOTORS, Inc.

Los Angeles 54, Calif. Milford, Conn.

MAIL THIS COUPON FOR DESCRIPTIVE BULLETIN

U.S. ELECTRICAL MOTORS, Inc. ME

Los Angeles 54, Calif., or Milford, Conn.

Send Bulletin 1515 featuring U.S. Varidrive Motor.

Name_____

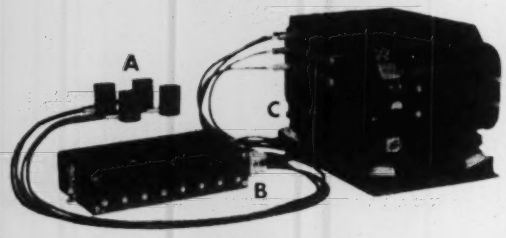
Company_____

Address_____

City_____ Zone____ State_____

New Dynamic Vibration MEASUREMENT and RECORDING

. . . without Amplifiers



SYSTEM B, CLASS 1—4 CHANNEL
Includes (A) Velocity Pickups, (B) Matching Network, and (C) Recording Oscillograph with Integrating Galvanometers.

CONSOLIDATED'S revolutionary, new DYNAMIC RECORDING system provides industry with a low-cost means of quantitative measurement and wave-form analysis of vibratory amplitude.

Operating entirely without electronic tubes, this new DYNAMIC RECORDING system offers sensitivity, accuracy, and frequency response equal to that of many expensive and complicated amplifier systems.

This new system, designed to increase still further the utility and flexibility of Consolidated Recording Oscillographs, is assembled around two new Consolidated instruments — the Integrating Galvanometer and the Matching Network.

The Integrating Galvanometer, Type 7-253, represents an innovation in today's recording techniques. Integration is performed *mechanically* by the galvanometer, rather than by high-loss R-C networks, at an efficiency so great that it may be operated directly from the output of velocity-type vibration pickups. Designed in the standard Series 7-200 galvanometer case, it is interchangeable with other Consolidated galvanometers.

The Matching Network, Type 8-201, is a precision four-channel unit, consisting of individual impedance-matching transformers and six-step attenuators for each channel. The case is designed for stacking with other Consolidated products and utilizes standard Cannon connectors.

For further information, send for Bulletin CEC-1517-X3.

SPECIFICATIONS

Frequency Range: Flat (±4%) from 10 to 1000 cps.

Sensitivity (Magnification): 250 : 1, when used with Consolidated Type 4-102A Vibration Pickup or equivalent. Example: 4 mils (.004 in.) vibratory amplitude will produce a recorded trace of 250 x .004 = 1.000 in. double amplitude.

CONSOLIDATED ENGINEERING CORPORATION
Analytical Instruments for Science and Industry
620 NORTH LAKE AVENUE, PASADENA 4, CALIFORNIA

Hand in Hand

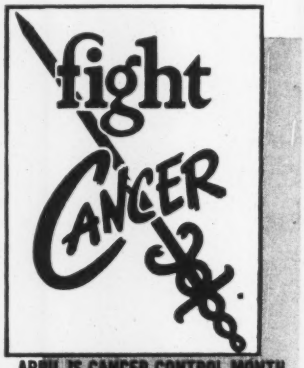
A quick glance over the list of our long-time customers shows that many of the larger ones started small. That's why we make it a continuing policy *to give the same close attention to every order, regardless of size.*

You'll never have a gear problem too small to interest us. For, in our forty-five years of manufacturing and selling gears of all types, it has become increasingly evident that good *service to all and our future business success*—go hand in hand.

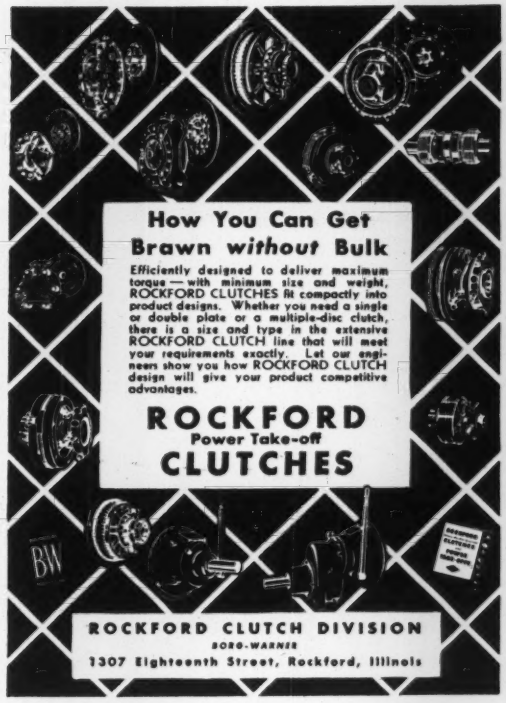
THE EARLE GEAR & MACHINE CO., 4707 Stanton Ave., Philadelphia 44, Pa. Sales Offices: New York City; Youngstown, Ohio.

It's good business to do business with EARLE.

EARLE GEARS



APRIL IS CANCER CONTROL MONTH
GIVE
AMERICAN CANCER SOCIETY



How You Can Get Brawn *without* Bulk

Efficiently designed to deliver maximum torque — with minimum size and weight, ROCKFORD CLUTCHES fit compactly into product designs. Whether you need a single or double plate or a multiple-disc clutch, there is a size and type in the extensive ROCKFORD CLUTCH line that will meet your requirements exactly. Let our engineers show you how ROCKFORD CLUTCH design will give your product competitive advantages.

ROCKFORD
Power Take-off
CLUTCHES

ROCKFORD CLUTCH DIVISION
BORG-WARNER
1307 Eighteenth Street, Rockford, Illinois

FLEXLOC

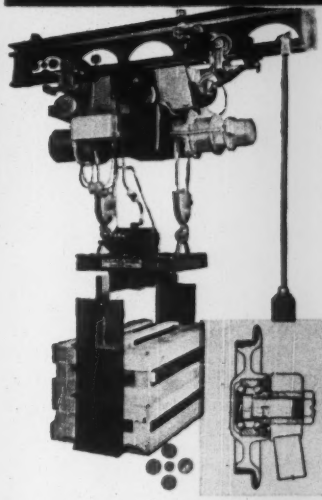
ONE-PIECE SELF-LOCKING NUTS

The FLEXLOC is one-piece, all-metal . . . has ample tensile and long life. It is a Stop and Lock-Nut that can be reused many times. Its "chuck-like", resilient locking segments lock the FLEXLOC securely in any position on a threaded member. It positively "won't shake loose", yet can be removed easily with a wrench.

Write for Catalog 619, it's full of Information.

See us at Space 128, A.S.T.E. Exposition, April 10-14, Convention Hall, Phila.

SPS STANDARD PRESSED STEEL CO.
JENKINTOWN 20, PENNSYLVANIA



Over 30,000 installations . . . handling nearly every conceivable type of material in practically every industry —that's the agressive materials handling record behind Cleveland Tramrail systems.

Aetna double race type wheel bearing No. A-827 as used in Cleveland Tramrail Systems.

Included among their sturdy components are hard working wheel bearings to meet the high load capacity, precision smoothness and long, trouble-free performance required in this application—bearings which Aetna has proudly supplied for over 14 years.

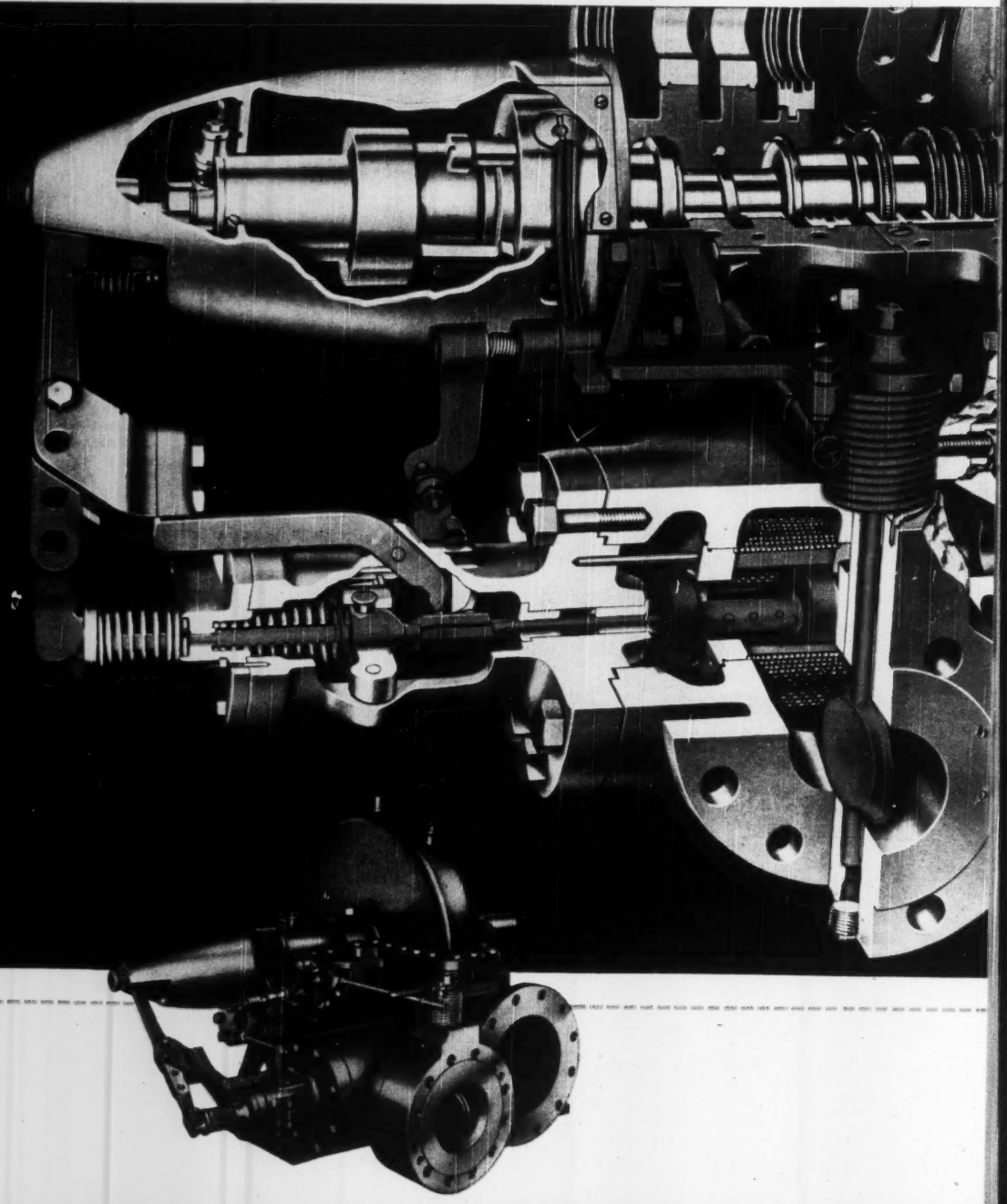
Greater efficiency is an advantage which comes to any hard working equipment when Aetna bearings lend a hand. For money saving, problem solving counsel on your next bearing application, submit your prints to Aetna. No obligation, of course!

AETNA BALL AND ROLLER BEARING COMPANY
4600 SCHUBERT AVENUE • CHICAGO 39, ILLINOIS

Aetna

YOU CAN BE **SURE**.. IF IT'S

Westinghouse



It's DOUBLE-safe!

With Type E turbines, you can be sure of protection against overspeed. You can be doubly sure.

A sensitive, powerful centrifugal-weight governor provides extremely accurate speed control. Both the governor and its linkage connection are enclosed in a strong, specially-shaped housing to protect them from damage.

However, if for any reason the governor loses control, Type E *dual* protection takes over. A corrosion-resistant, spring-restrained weight, mounted in the governor hub, strikes a trip linkage . . . instantly closes the governor valve and an independent steam inlet butterfly valve. Steam is cut off positively . . . danger and resulting damage of overspeed are avoided.

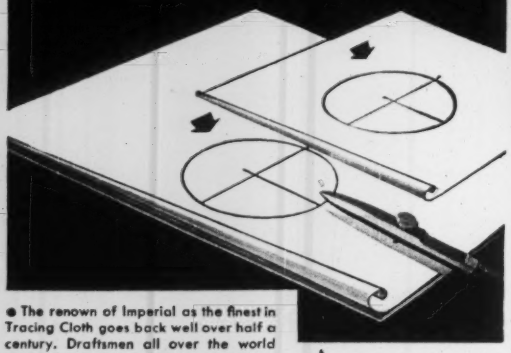
Dual protection is but one of the significant features of Type E turbines. Wrapped up in one standard unit are the best features of previous Westinghouse mechanical drives, plus important refinements and new developments that add up to economical, dependable service under all operating conditions.

We invite your comparison . . . on *any* count. Get the facts from your nearby Westinghouse office, or write for 20-page book B-3896. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-50499

Westinghouse TYPE E Turbines

WESTINGHOUSE

TRACING CLOTH THAT DEFIES TIME



● The renown of Imperial as the finest in Tracing Cloth goes back well over half a century. Draftsmen all over the world prefer it for the uniformity of its high transparency and ink-taking surface and the superb quality of its cloth foundation.

Imperial takes erasures readily, without damage. It gives sharp contrasting prints of even the finest lines. Drawings made on Imperial over fifty years ago are still as good as ever, neither brittle nor opaque.

If you like a duller surface, for clear, hard pencil lines, try Imperial Pencil Tracing Cloth. It is good for ink as well.

IMPERIAL TRACING CLOTH

SOLD BY LEADING STATIONERY AND DRAWING MATERIAL DEALERS EVERYWHERE

You'll do better work... faster and easier... with a

Hamilton Auto-Shift Table!

HERE'S WHY Regardless of the job, your Auto-Shift gives you the best possible working position. Instant, finger-tip control of height and slope lets you work on any part of the drawing in a relaxed, effortless way.

Standing or sitting—in horizontal or vertical board position—for work or discussion—the *flexibility* of your Auto-Shift speeds production. You'll like the conveniences of instrument storage and the work-sized reference space, too.

We want you to know all about Hamilton Auto-Shift Tables. It costs nothing, but will save you time and money—just use this handy coupon.

Hamilton Manufacturing Company, Two Rivers 19, Wisconsin
I'd like to know more about Hamilton Auto-Shift Tables.

Name _____

Firm _____ Position _____

Address _____

City _____ Zone _____ State _____

Hamilton Manufacturing Company
TWO RIVERS, WISCONSIN

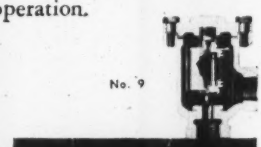
© 1950 HAMILTON MANUFACTURING COMPANY

NATURE *Insists* ON INDIVIDUAL TRAPPING

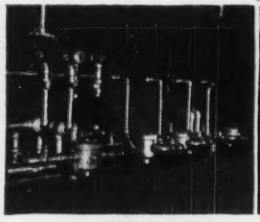
—and no waiting! But in your plant there may be slow-ups and other production headaches because a single large steam trap is supposed to drain a whole battery of machines or a number of individual coils or jackets.

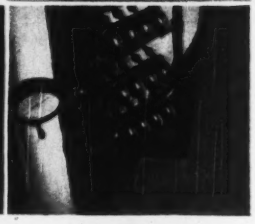
Use individual trapping—a separate trap on each unit and make sure that condensate is not held back to slow up your operation.

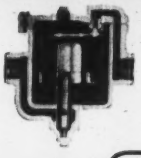
THE SELECTION of the right steam trap is not difficult. Sarco Selection Chart No. 1600 shows first and second preference for standard applications, or the Sarco man will study and recommend for every process in your plant.



No. 9







BUCKET

FLOAT-THERMOSTATIC

253

SARCO SAVES STEAM

SARCO COMPANY, INC.
Represented in Principal Cities
Empire State Building, New York 1, N.Y.
SARCO CANADA, LTD., TORONTO 5, ONTARIO

IMPROVES PRODUCT QUALITY AND OUTPUT

For Moving Pipe Lines

FLEXO JOINTS

For safe, unrestricted flow, Flexo Joints offer the strength of pipe *plus* the flexibility of hose — to convey fluids through movable pipe lines or to equipment while in motion. Just four simple parts, completely enclosed—no springs—no small or loose parts . . . long wear—low maintenance. Four styles—standard pipe sizes ¼" to 3".

Write for complete information.

FLEXO SUPPLY CO., Inc.

4652 Page Blvd. St. Louis 13, Mo.

In Canada: S. A. Armstrong, Ltd., 1400 O'Connor Drive, Toronto 13, Ont.

?

IS YOUR COMPANY LISTED
IN THE
·A·S·M·E·
MECHANICAL CATALOG AND DIRECTORY

●

USE YOUR 1950 VOLUME
TO CHECK IF YOUR FIRM IS LISTED

●

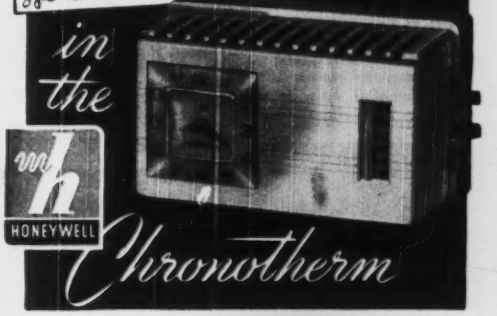
If not listed, write to us upon your Company letterhead, informing us under what product classifications your firm should be listed.

The American Society of Mechanical Engineers
29 West 39th Street, New York 18, N. Y.

CHACE BIMETAL

TRIPLE DIVIDEND

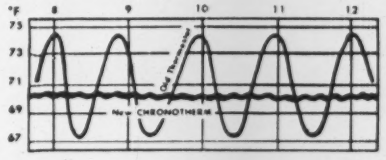
in the



No. 38—Product of Minneapolis-Honeywell Regulator Co. Minneapolis 8, Minnesota

Chace Thermostatic Bimetal actuates this new Minneapolis Comfort Thermostat that offers homeowners the triple dividend of: (1) Annual fuel savings up to 11%. (2) Constant comfortable indoor temperature. (3) Service . . . unattended . . . from Fall to Spring.

Operating on a new principle, "Time Modulation", the Chronotherm produces short, frequent, moderate burner operations. Steam, water or air in the heating system is kept at a constant, moderate temperature; when the thermostat calls for additional heat correct warmth is immediately available. Thus room temperature variation is kept within a *fraction of one degree.*



Maintaining this hairline control is Chace No. 6650 Bimetal. This material, of extremely high deflection rate and torque, is one of thirty Chace Bimetals that build dependability and saleability into countless products. When selecting an actuating element for your device, take advantage of our long experience in the fields of temperature response, indication and control. Our engineering department can assist you, and invites your inquiry.

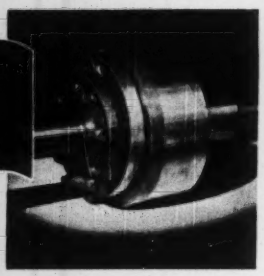
IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1619 BEARD AVE., DETROIT 9, MICH.

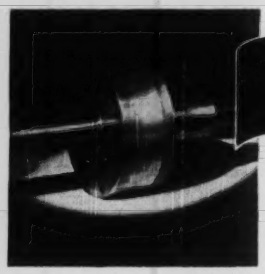
HILLIARD *Clutches*

FOR POWER CONTROL DESIGNS

HILLIARD
SINGLE
REVOLUTION
CLUTCH



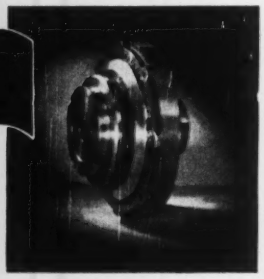
Unequalled for accurate control of intermittent machine operations — cutting, punching, and packaging. Gives closer tolerances to cut-off, stamping, shearing, and similar machines. Completely automatic; manual, mechanical, or electrical control.



HILLIARD
OVER-RUNNING
CLUTCH

Hilliard Over-Running Clutches and Couplings are automatic in operation. They are unexcelled for automatic two-speed drives, dual drives, stand-by drives, and for allowing machinery to "coast" after drive stops. Excellent as fixed or infinitely adjustable ratchets.

HILLIARD
SLIP
CLUTCH



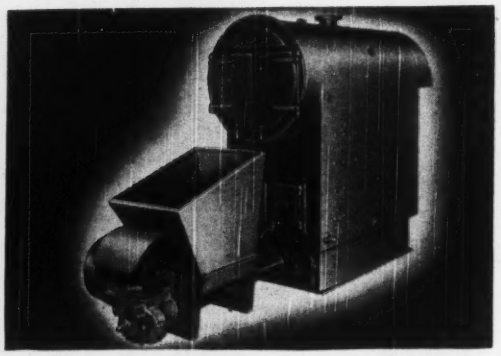
A reliable series of spring-loaded slip clutches and couplings. Rugged construction with ample friction surface for heavy-duty use. Outstanding for preventing overloads and shocks; for starting heavy loads; as tension drag brakes; for reeling and winding operations; and many other uses.

Hilliard's Engineering Department is ready to assist you in designing installations and in selecting the correct clutch or coupling.
Write today — 3 Hilliard Clutch Bulletins with design information. Free on request.

Clutch Makers for over 40 years

The HILLIARD Corporation

149 West Fourth Street---ELMIRA, N. Y.



NEW *UNITBILT* COMBINATION

The furnace ironwork is factory-installed. Shipment consists of only three pieces. Assembly on location is merely a matter of connecting the drive unit (including hopper) to the boiler base—an hour's job.

The unique boiler-stoker combination is built in ten sizes with steam radiation capacities of 2190 to 8500 sq. ft. Suitable for schools, apartment buildings, garages, greenhouses, dairies, processing plants, etc. Stokers and boilers are strictly Brownell products—backed by the nearly century-old Brownell reputation.

For complete information, ask for Bulletin SF-1. Do it now while you're thinking of it.

THE BROWNELL COMPANY

446 N. FINDLAY ST. DAYTON 1, OHIO

MECHANICAL ENGINEERING
February, 1950 CARD INDEX **Vol. 72, No. 2**

L. Prandtl—A Tribute in Honor of His Seventy-Fifth Birthday . . 116
Guarding Apprenticeship—Our Priceless Heritage, D. F. Pratt . . 117
Differentiating Characteristics of an Engineering Curriculum, S. C. Hollister . . 122
Instrument Engineering—Its Growth and Promise in Process-Control Problems, G. S. Brown and D. P. Campbell . . 124
The Outlook for Ceramics in Gas Turbines, W. H. Duckworth and I. E. Campbell . . 128
Housings and Spindles for Antifriction Bearings, H. L. Blood . . 131
Selecting Antifriction Bearings for Machine Tools, J. H. Basinger . . 134
Characteristics of Greases as Related to Antifriction Bearing Applications, E. S. Carmichael and R. C. Robinson . . 137
Maintenance of Antifriction Bearings, J. M. Bruening . . 142
Job Satisfaction and Labor Mobility, G. P. Shultz . . 145
Editorial . . 115
Briefing the Record . . 147
ASME Technical Digest . . 159
Contents of ASME Transactions . . 167
Reviews of Books . . 168
ASME Boiler Code . . 172
The Engineering Profession—New sand Notes . . 176
ASME News . . 180
ASME Junior Forum . . 189
Engineering Societies Personnel Service, Inc . . 196

MECHANICAL ENGINEERING
March, 1950 CARD INDEX **Vol. 72, No. 3**

Developments in River Transportation of Petroleum, C. R. Horton, Jr . . 205
Mechanized Job-Shop Foundry for Aluminum, C. H. De-Lamater . . 211
Absorption Refrigeration, A. A. Berestneff . . 216
Quality-Control Indicator, R. C. Miles . . 221
New Concepts of Abrasive Properties as Affecting Grinding Performance, H. W. Wagner . . 225
Aviation As An Instrument of Peace, H. L. Dryden . . 227
The Obligation of Management To Provide Leadership, F. S. Blackall, Jr . . 229
Registration by Endorsement, D. B. Steinman . . 232
Editorial . . 203
Briefing the Record . . 235
ASME Technical Digest . . 247
Contents of ASME Transactions . . 251
Comments on Papers . . 252
Review of Books . . 259
ASME Boiler Code . . 261
Engineering Profession, News, Notes . . 263
ASME News . . 267
ASME Junior Forum . . 272
Engineering Societies Personnel Service, Inc . . 276

Representatives—Sales Agencies
Business for Sale
Partnership—Capital
Manufacturing Facilities

OPPORTUNITIES

Positions Open—Positions Wanted—Equipment, Material, Patents, Books, Instruments, etc. Wanted and For Sale

Answers to box number advertisements should be addressed to given box number care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

POSITIONS OPEN

MECHANICAL ENGINEER

For Mechanical Design and Engineering Studies in connection with Electric Utility work. Should have 15 years' experience in similar work.

Write to: Mechanical Engineer, Pennsylvania Power & Light Company, Allentown, Pennsylvania.

ELECTRICAL AND MECHANICAL PRODUCTION ENGINEERS

Guided Missile Manufacture
Los Angeles Area

Experienced in development of processes and design of equipment and tooling for ULTRA-PRECISION MINIATURE MECHANISMS.

Also supervisory openings for top-caliber men with wide knowledge of latest developments applicable to production of one or more guided missile components.

Send resumé of your experience to Dept. 29B, Hughes Aircraft Company, Culver City, Calif. Interviews will be arranged near your home if possible.

RATES Classified Advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $1.25 a line. $1.00 a line to members of ASME. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis. Display Advertisements carried in single column units of multiples of one inch at flat rate of $20 per inch per insertion. Maximum size: 1 column, 10 inches deep; 2 columns, 5 inches deep. Copy must reach us not later than the 10th of the month preceding date of publication.

ADMINISTRATIVE ENGINEER

for manufacturer of small precision machine tools. Capable of directing engineering projects and supervising product designers and development engineers. Must know tooling and production methods. Shop background desirable. Salary up to $15,000 for top-flight man, age 35 to 45. Location St. Louis; medium size plant. Give details of experience, education, personal data.

Address CA-3176, care of "Mechanical Engineering."

Use a CLASSIFIED ADVERTISEMENT *for Quick Results*

FIELD SERVICE ENGINEER

Graduate E.E., M.E. or A.E., age 25 to 35 years. Free to travel extensively. Experience in servicing aviation, electronic or related equipment. Willing to fly in commercial, military and company planes. Interested in public contact and be able to carry responsibility in that connection. Please reply in writing with full particulars to Mr. J. Arthur Johnson, Employment Manager, Minneapolis-Honeywell Regulator Company, 2753 Fourth Avenue South, Minneapolis 8, Minnesota.

OPENINGS FOR DESIGN ENGINEERS

We have several immediate openings for design or development engineers. Mechanical and electrical engineers with considerable experience in design of instruments or control preferred. Excellent opportunities with leading manufacturer of automatic controls. Attractive salary. Location: Minneapolis. Contact J. Arthur Johnson, Employment Manager, Minneapolis-Honeywell Regulator Company, 2753 Fourth Avenue South, Minneapolis 8, Minnesota.

VALVE DESIGNER—For steadily growing Chicago area company. Prefer man with design experience in the steel valve field. This is a board position. Salary commensurate with ability and experience. Address CA-3104, care of "Mechanical Engineering."

ASSISTANT TO CHIEF ENGINEER—Excellent opportunity with a progressive company in the Chicago area, for a mechanical engineer experienced in valve design. Send details of qualifications. Address CA-3105, care of "Mechanical Engineering."

ASSISTANT CHIEF ENGINEER—by midwest regulating valve manufacturer. Must be competent designer in valve and control instrument field with thorough application knowledge. $6500 with bonus for outstanding performance. Address CA-3137, care of "Mechanical Engineering."

HYDRAULIC OR MECHANICAL ENGINEER—Designer with experience in application of hydraulics to machine tools. Position open with well-established New England concern. In reply, please give full details of experience and background. Address CA-3144, care of "Mechanical Engineering."

MECHANICAL AND ELECTRICAL ENGINEER—Excellent opportunity for young man with approximately seven years' experience in design, specifications and supervision of the mechanical and electrical phases of building construction, with particular emphasis on school and institutional work. Full partnership offered for right man in established engineering office. Location New England. Address CA-3156, care of "Mechanical Engineering."

ASSOCIATE PROFESSOR—Progressive land grant college located in the southeast has opening for a man trained and experienced in the field of Machine Design. Should be qualified to teach both graduate and undergraduate courses. Give detailed information in first letter. Address CA-3160, care of "Mechanical Engineering."

DESIGNER OR DRAFTSMAN—experience on time clocks. Long established, medium sized concern near N.Y.C. Address CA-3175, care of "Mechanical Engineering."

INSTRUCTOR IN MECHANICAL ENGINEERING—Some industrial experience desirable. Permanent position for the right man. Salary $3,100 to $3,200. Should have Master's degree, or started work on it. A. M. Hill, College of Engineering, Tulane University, New Orleans 18, La.

TOP-NOTCH EXECUTIVE—to oversee construction program and later operate 35,000 KW generation and transmission system. The man we want must have proven management competence. Apply to A. J. Pow, President, East River Electric Power Cooperative, Inc., Milbank, South Dakota.

GRADUATE ENGINEER—26–32, experienced in application and maintenance of instruments and controls in power plants. Position is open in engineering department of large utility company. Some traveling required. Salary $5600-4500. New York. Address CA-3184, care of "Mechanical Engineering."

SUPERVISORY MECHANICAL ENGINEER—to supervise design and development of canning and food processing equipment. Must have at least ten years' experience, references in food processing, packaging, or filling machinery; personality and executive ability important. Address CA-3185, care of "Mechanical Engineering."

MACHINE DESIGNER—with ten to fifteen years' experience in light and heavy automatic machinery. Must be able to carry project and design through from start to finish with minimum supervision. Some glass machine experience desired, but not necessary. Address CA-3186, care of "Mechanical Engineering."

FILTER DESIGN ENGINEER—for reputable Midwestern manufacturer of automotive equipment. Chemical or mechanical engineering graduate with 1 to 2 years of filter experience desired. Excellent opportunity for a young man who wishes to progress in this field. Write stating education, experience, and salary desired. Address CA-3187, care of "Mechanical Engineering."

POSITIONS WANTED

MECHANICAL ENGINEERING—Member of A.S.M.E.; Age 48, Married; Registered Graduate Engineer, now employed, desires change for a more responsible position as Mechanical or Assistant Chief Engineer. Twenty years of diversified mechanical experience involving Design, Testing, Patent Developments, Inspection, and Administration Duties. Will travel if necessary. Address CA-3134, care of "Mechanical Engineering."

CHIEF ENGINEER—age 36, with 12 years' experience Oil and Gas Fired Domestic Heating Equipment. Can take full charge of design, development, tests, and obtaining approval new models. Desires connection with progressive organization. Minimum Salary $10,000. Address CA-3161, care of "Mechanical Engineering."

Continued on Page 116

Two Pages of "OPPORTUNITIES" This Month . . . 115-116

POSITIONS WANTED

Continued from Page 115

PATENT ENGINEER—37, married, graduate engineer. Nine years' general industrial experience. One and a half year experience in patent-work. Employed at present. Desires position in patent department of industrial firm or patent office. Location West Coast preferred. Address CA-3163, care of "Mechanical Engineering."

MECHANICAL ENGINEER—centrifugal pump designer—30 years' experience in design, development and efficiency improvement. Job satisfaction more important than salary. Address CA-3164, care of "Mechanical Engineering."

GRADUATE MECHANICAL ENGINEER—M.E. Cornell Univ., Member A.S.M.E., family, excellent educational and experience background. 13 years' successful mechanical engineering experience in research, development, design, and testing relating to both process and product activity in the electro-mechanical, structural, machine design, and chemical fields. Able, experienced liaison, supervision, travel, report writing. Desires permanent, responsible position with progressive organization where integrity, varied experience, and creative ability will be valued assets. Resumé on request. Address CA-3165, care of "Mechanical Engineering."

MECHANICAL ENGINEER—age 27—Master's Degree in Applied Mechanics—3½ years' teaching experience—Desires design or research in East or Mid-West—Member A.S.M.E., N.Y.S.S.P.E., others—Available June 19. Address CA-3166, care of "Mechanical Engineering."

SALES ENGINEER—35—10 years' experience in light, heavy machinery. Have "Know How" on increasing sales with knowledge of production methods and design. Will relocate. Address CA-3168, care of "Mechanical Engineering."

MECHANICAL ENGINEER—BME University of Minnesota, December 49, age 26, vet. W.W.II. Desires Sales Engineering position with promising future, in the East. Resumé furnished on request. Address CA-3169, care of "Mechanical Engineering."

DESIGN ENGINEER—5½ years' chemical plant, 1½ years' petroleum and 1 year food process design. Age 31, Married, B.S.Ch.E. Interested in foreign construction. Particularly desirous of foreign employment. Address CA-3170, care of "Mechanical Engineering."

PATENT ATTORNEY, MECHANICAL ENGINEER—P.E. New York, can devote part time weekly to patent matters in client's offices. New York district. Cooperate with engineering department in development work to evade infringement. Over 30 years' experience handling mechanical cases. Address CA-3171, care of "Mechanical Engineering."

MECHANICAL ENGINEER—38, B.S. in M.E. Extensive experience in definition and solution of economic and technical problems relating to the utilization and generation of electric power and steam. Experienced in supervision and direction of the mechanical engineering and design of industrial and utility steam plants. Sound knowledge of fundamentals and thoroughly realistic appraisal of situations. Desire temporary or permanent affiliation. Will travel. Address CA-3172, care of "Mechanical Engineering."

GRADUATE MECHANICAL ENGINEER—34, Registered, 11 years' engineering experience in heavy manufacturing production planning, design, installation, process, supervision and maintenance. Employed. Wants Plant Engineering job. Resumé on request. Address Ray W. Dallner, 511 N. Vine St., Marshfield, Wisconsin. Phone 1329-R.

MECHANICAL AND QUALITY CONTROL ENGINEER—Registered, member of A.S.M.E., A.S.A., A. Soc. Quality Control. Proficient in planning research and inspection. Can apply modern statistical methods to research, inspection and quality control activities. Qualified for executive or staff position in manufacturing, inspection and research divisions. Address CA-3174, care of "Mechanical Engineering."

Displaced person GRADUATE ENGINEER WANTS JOB AS DRAFTSMAN. One year's drafting experience in U. S. Top notch references. First papers. Alien questionnaire WD-AGO-19-99 in process but must eat in meantime. Fluent in German, English, Russian, Yugoslav. V. V. Grigorovitch, 703 Huron Street, Schenectady, N. Y.

COMBUSTION, STEAM ENGINEERING, AIR POLLUTION—specialized mechanical engineer, 29, masters degree, U.S. and British experience desires change of position: Development, consulting or sales. Address CA-3183, care of "Mechanical Engineering."

If you desire capital or have it to invest; if you have a patent for sale or development; if you have on hand used machinery for disposal, or if you want such equipment; if you have copies of publications, or a set of drawing instruments to dispose of; if you need help or want a position, in fact, anything to be offered that somebody else may want, or anything wanted that somebody else may have—

Use a Classified Advertisement in

MECHANICAL ENGINEERING

for Quick Results

REPRESENTATION WANTED

PROMINENT MANUFACTURER OF CENTRIFUGAL PUMPS—desires to receive applications from manufacturers' agencies capable of giving aggressive sales representation to an extensive line, well cataloged and complete (does not include boiler feeders). Open territories are: Bangor, Charlotte, Cincinnati, Columbus, Des Moines, Harrisburg, Helena, Jacksonville, Little Rock, Memphis, Milwaukee, Norfolk, Peoria, Reno, Richmond, Scranton, Springfield, Mass., Toledo, Wichita, Wilmington, Del., Youngstown. Address CA-3173, care of "Mechanical Engineering."

REPRESENTATIVES AVAILABLE

SELLING OPPORTUNITY WANTED—New York sales organization with six sales engineers needs a superior instantaneous steam water heater or other heat exchanger for all or part of Southern and Central New York State and New Jersey. Now selling steam traps, control valves, etc., to industrials, utilities and institutions. Address CA-3143, care of "Mechanical Engineering."

MANUFACTURERS' REPRESENTATIVE—established in N. Y., N. J., Conn. Desires an additional line. Machinery or equipment. Address CA-3167, care of "Mechanical Engineering."

EMPLOYMENT AGENCIES AND SERVICE BUREAUS

PLANT PERSONNEL, ENGINEERS, DESIGNERS—Draftsmen, Chemists, and Metallurgists, E. G. Stroud, Member A.S.M.E. and President Cleveland Engineering Agency Co., 2132 E. 9th St., Cleveland 15, Ohio, will help you find positions or men.

SALARIED POSITIONS $3,500-$35,000. If you are considering a new connection, communicate with the undersigned. We offer the original personal employment service (40 years' recognized standing and reputation). The procedure, of highest ethical standards, is individualized to your personal requirements and develops overtures without initiative on your part. Your identity covered and present position protected. Send only name and address for details. R. W. Bixby Inc., 115 Dun Bldg., Buffalo, N. Y.

SALARIED PERSONNEL $3,000—$25,000

This confidential service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions, assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited.

JIRA THAYER JENNINGS
Dept. J, 241 Orange Street, New Haven, Conn.

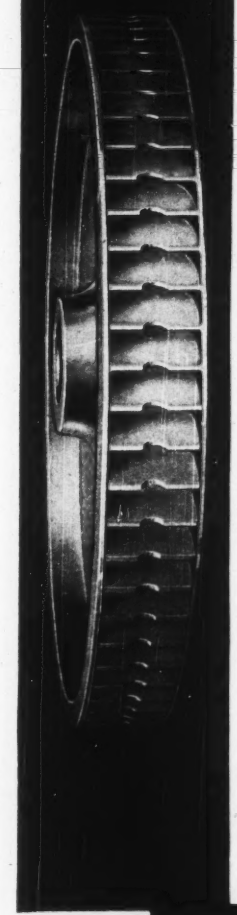
It will pay you to watch the announcements on these pages for an opportunity that you may be looking for or one that may be of interest to you.

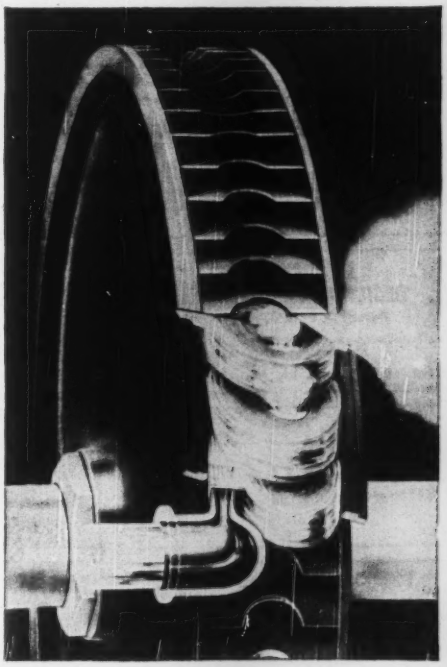
BUYER'S CATALOG GUIDE

. . . LATEST INDUSTRIAL LITERATURE

Beginning on page 41 the "Buyer's Catalog Guide" offers readers of MECHANICAL ENGINEERING an opportunity to secure the latest industrial literature available. There are 162 items to make selections from. For convenience, an index may be found on pages 41 and 42. Select desired catalogs by number, fill in coupon on page 42 and mail promptly. (*Must be mailed on or before date given on coupon.*)

TERRY





Action of steam in Terry wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket in which its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

NO PARTS TO LOOSEN OR WORK OUT

The rotor of the Terry Wheel Turbine is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to become loose or work out.

The power-producing action of the steam takes place on the solid curved backs of these buckets or pockets. Therefore close clearance is unnecessary and wear on the blades forming the pockets is of little consequence, as it does not materially affect horsepower or efficiency.

For detailed information about this effective construction and its advantages, write us on your business letterhead for a copy of Terry Turbine Bulletin S-116.

T-1172

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

RATES One Inch Card Announcements inserted at rate of $15.00 per issue, $12.00 per issue on yearly contract

ENGINEERING SERVICE

Manufacturers of Equipment Not Included

BLACK & VEATCH
CONSULTING ENGINEERS
Electricity—Water—Sewage—Industry
Reports, Design, Supervision of Construction
Investigations, Valuation and Rates
4706 Broadway — Kansas City 2, Missouri

GEORGE H. KENDALL
Consulting Mechanical Engineer
Cost Reduction Studies: Process or Product.
Redesign Existing Products for Greater Profit.
Trouble Shooting Production, Design, Cost Problems.
Specialist Automatic Machinery, Processes, Controls.
New Developments, Patent Studies, Investigations.
New Products & Process Engineering Studies.
P. O. Box 72 (Est. 1923) Tel. Darien 5-1504
Noroton Heights — Darien, Connecticut

Metallurgists
Analysts **Consultants**
Spectroscopists
PHILADELPHIA TESTING LABORATORIES
900 W. Vanango Street
Philadelphia 40, Pa.

BROWN ENGINEERING COMPANY
Consulting Engineers
Power Plants, Substations, Transmission,
Water Supply, Sewage Disposal, Rates
K. P. Building — Des Moines 9, Iowa

LANCASTER, ALLWINE & ROMMEL
Registered Patent Attorneys
Patent Practice before U. S. Patent Office, Validity and Infringement Investigations and Opinions. Booklet and form "Evidence of Conception" forwarded upon request.
Suite 479, 815-15th St., N. W., Washington 5, D. C.

Consult **Z. H. POLACHEK**
Reg. Patent Attorney
1234 Broadway
(at 31st St.) New York 1, N. Y.
Phone LO 5-3088

M. BUCHSBAUM
DESIGN CONSULTANTS, INC.
Research and Development
Aerodynamics—Structures—Product Design
Electronic Instrumentation
Suite 1017, 521 Fifth Ave., New York 17, N. Y.

Industrial Power—Surveys & Design
MYERS & ADDINGTON
Consulting Engineers
21 East 40th Street, New York 16, N. Y.
Murray Hill 6-4630

SANDERSON & PORTER
ENGINEERS AND CONSTRUCTORS
New York • San Francisco • Chicago • Los Angeles

THE CARLSON COMPANY
Spring Design Specialists
Mechanical Product Development
277 Broadway — New York 7, N. Y.
Phone: Barclay 7-2552

WELD TESTING
Qualification of Operators—Supervision
Inspection—Research
NATIONAL WELD TESTING BUREAU
Pittsburgh Testing Laboratory, Pittsburgh, Pa.

Power Plants, Structures,
Transmission Systems
Design, Supervision, Inspection
Appraisals, Reports
SARGENT & LUNDY
140 S. Dearborn St., Chicago, Ill.

EHRCO DIE CASTING SERVICE
Die Casting Consultation
Equipment — Installation
Die and Product Design
John R. Ehrbar, Pres.
303 Main Street, Stamford, Connecticut
Telephone 3-2308

GEORGE B. OUJEVOLK
Patent Attorney
Canadian Patent Agent
Philippines Trademark Attorney
509 Fifth Avenue — New York 17, N. Y.

STANLEY ENGINEERING COMPANY
CONSULTING ENGINEERS
Power Plants
Steam - Diesel - Hydro
Design - Construction - Test - Valuation
Surveys
Hershey Building — Muscatine, Iowa

C. M. HATHAWAY
CONSULTING ENGINEER
Project Engineering, Product Development,
Production Designs, Laboratory and Shop
Facilities for Research, Model Work,
and Pilot Manufacturing
1315 S. Clarkson Street — Denver 10, Colorado

An announcement in this section will acquaint others with your specialized practice.

ST & CO., INC.
DESIGNING ENGINEERING
Machines • Products • Plants
Processes • Production • X-Ray
SAM TOUR & CO., INC.
44 TRINITY PL., N. Y. 6, N. Y.

MPB makes more than **50** types and sizes of miniature ball bearings

BEARINGS, Ball, miniature. Standard and Special for application in precision mechanisms to minimize friction and wear. High load capacity in minimum space. Light in weight. Specify MPB for shock loads, continuous operation, extreme temperature ranges and delicate responsiveness. Special designs and complete engineering service for your application. Write for catalog M.

MPB MINIATURE *Precision* BEARINGS
INCORPORATED
KEENE, NEW HAMPSHIRE, U.S.A.

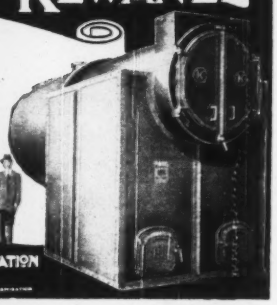
Hi-Test KEWANEE

FOR POWER and PROCESS STEAM

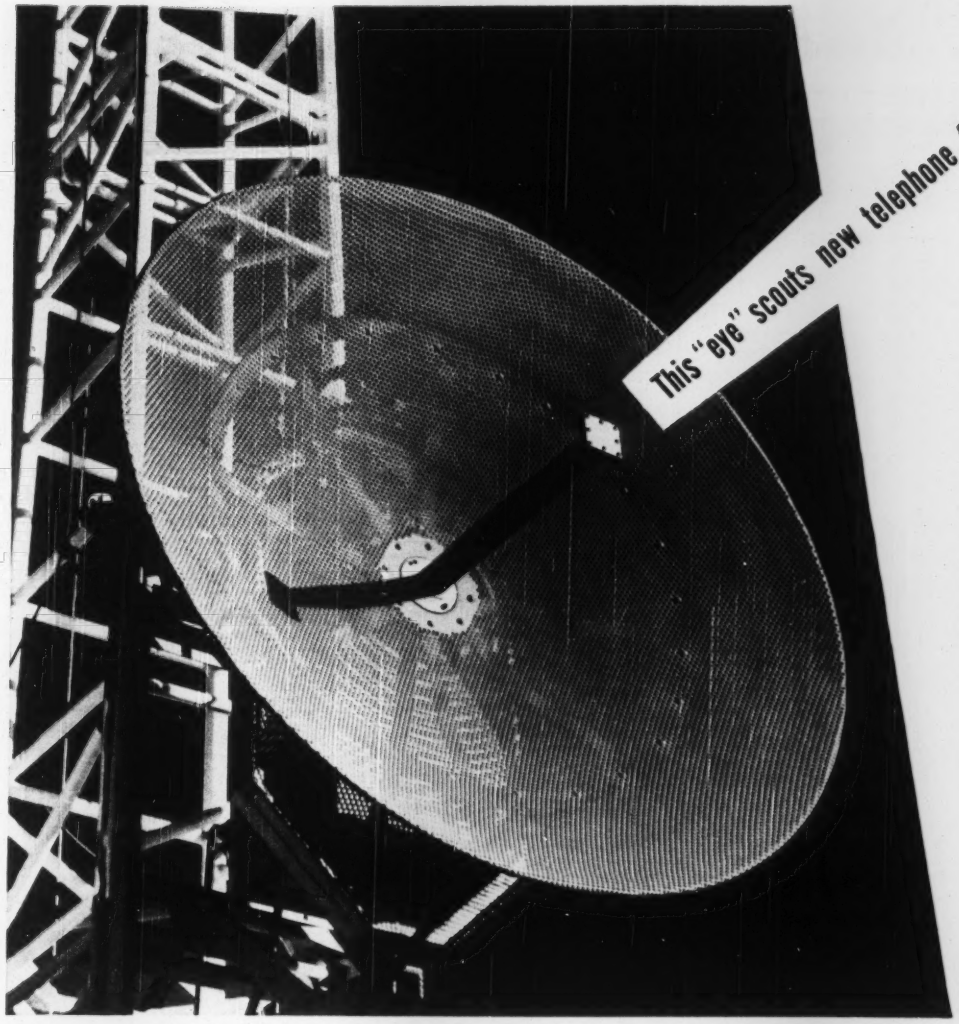
All-welded Portable with fire-box for refractory lining and fuel-conserving 2-pass tubes. A Q-u-i-c-k Steamer.
6 sizes, 50 to 150 H.P., 125 and 150 lbs. W.P.

80 Years Boilermakers

Write Dept. 89-M4 for 6" scale with pipe diameter markings.



KEWANEE BOILER CORPORATION
KEWANEE, ILLINOIS



This "eye" scouts new telephone frontiers

Throughout history, scouting parties have gone out ahead of man, ahead of settlements, ahead of civilization itself. Today, Bell System scouts are engaged in a new kind of exploration — charting a path for microwaves — using equipment specially designed by Bell Telephone Laboratories.

The portable tower shown is constructed of light sections of aluminum and in a few hours may be built up to 200 feet. Gliding on rollers, the "dish," with its microwave transmitter or receiver, is quickly positioned for line-of-sight transmission, then oriented through electric motors controlled from the ground.

Test signals show how terrain and local climate can interfere with microwave transmission. Step by step, Bell's explorers avoid the obstacles and find the best course for radio relay systems which will carry television pictures or hundreds of simultaneous telephone conversations.

A radio relay link similar to the one between New York and Boston will be opened this year between New York and Chicago. Later it will be extended, perhaps into a nation-wide network — another example of the way Bell Telephone Laboratories scientists help make the world's best telephone system still better each year, and at lowest cost.

BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE

Index To Advertisers

KEEP INFORMED—PAGES 61-68 • APRIL 1950 • OPPORTUNITIES—(classified ads) Pages 115-116

BUYER'S CATALOG GUIDE • The Latest Industrial Literature Available • Pages 41 to 60 Inclusive

*Aetna Ball & Roller Bearing Co. 109
All American Tool & Mfg. Co. 68
*American Blower Corp. 89
*American Felt Co. 27
ASME Publications 76
Amplex Mfg. Co., Div. of Chrysler Corp. 16
Arkwright Finishing Co. 56
Automotive & Aircraft Div., American Chain & Cable 104

*Babcock & Wilcox Co. 2nd Cover
Baldwin-Duckworth Div. of Chain Belt Co. 82, 83
*Barco Mfg. Co. 78
*Barnes-Gibson-Raymond, Div. Assoc. Spring Corp. 107
*Barnes, Wallace, Co., Div. Assoc. Spring Corp. 96
Bell Telephone Laboratories 119
Briggs & Stratton Corp. 57
Brown & Sharpe Mfg. Co. 121
*Brownell Co. 114

Carrier Corp. 22
Central Scientific Co. 58
Chace, W. M., Co. 113
Chain Belt Co. 82, 83
Chiksan Co. 60
Clark Equipment Co., Industrial Truck Div. 65
Climax Molybdenum Co. 50
*Combustion Engineering-Superheater (Inc.) 74
Consolidated Engineering Corp. 108

*DeLaval Steam Turbine Co. 94
*Detroit Stoker Co. 23
Diamond Chain Co. (Inc.) 99
Dowell (Inc.) 81
*Downingtown Iron Works 58
Drop Forging Association 91

Earle Gear & Machine Co. 108
Eastman Kodak Co. 69, 105
Economy Pumps (Inc.) Div. Hamilton-Thomas Corp. 20
Edward Valves (Inc.) Sub. of Rockwell Mfg. Co. 2, 3
Ellison Draft Gage Co. 102
*Engineer Co. 19
*Erie City Iron Works 32

*Fafnir Bearing Co. 25
*Farrel-Birmingham Co. 92
Farval Corp. 73
Fenwal (Inc.) 43
Flexo Supply Co. 113
*Foote Bros. Gear & Machine Corp. 15
*Foxboro Co. 95

*Garlock Packing Co. 86
Gear Specialties 5
*General Electric Co. 17, 18, 39, 93
General Radio Co. 12
*Goulds Pumps (Inc.) 63
Graphite Metallizing Corp. 46

★ The asterisk indicates that firm also has product catalog in the 1950 A.S.M.E. Mechanical Catalog and Directory

The Only Reference Annual Covering the Mechanical Engineering Field with a Unique Combination of Complete Equipment Directory and Manufacturers' Catalogs. Up-to-date 20-page Insert Catalog of A.S.M.E. Publications is included.

Published Annually By
The American Society of Mechanical Engineers
29 West 39th St., New York 18, N. Y.

*Grinnell Co. 103

*Hamilton Mfg. Co. 112
Hamilton-Thomas Corp. 20
Hathaway Instrument Co. 62
Helicoid Gage Div. American Chain & Cable 67
Hilliard Corp. 114
Hyatt Bearings Div., General Motors Corp. 33
Hydropress (Inc.) 13

Imperial Tracing Cloth 112
International Nickel Co. 34
Irving Subway Grating Co. 66

Jenkins Bros. 40
*Johns-Manville 80
*Jones, W. A., Foundry & Machine Co. 21

Kellogg, M. W., Co. 11
Keuffel & Esser Co. 70, 71
*Kewanee Boiler Corp. 118
*Kinney Mfg. Co. 51
Kunkle Valve Co. 102

Ledeen Mfg. Co. Div. Engineering Products Co. 50
*Leeds & Northrup Co. 72
Linear (Inc.) 4
*Link-Belt Co. 122
Lovejoy Flexible Coupling Co. 106
Lubriplate Div., Fiske Bros. Refining Co. 55

Lukens Steel Co. 24
Lunkenheimer Co. 10

Macmillan Co. 44
*Mears-Kane-Ofeldt (Inc.) 48
Midwest Piping & Supply Co. 87
*Miniature Precision Bearings (Inc.) 118
Morse Chain Co. 28, 29

*National Airoil Burner Co. 44
National Power Show 100
New Departure, Div. General Motors Corp. 1
*Newport News Shipbuilding & Dry Dock Co. 6
Niagara Blower Co. 49
Nordstrom Valve Div. of Rockwell Mfg. Co. 30, 31
Ozalid Div. of General Aniline & Film Corp. 45

*Peabody Engineering Corp. 59
Permutit Co. 3rd Cover
Philadelphia Gear Works 97
Posey Iron Works (Inc.) 98

*Republic Flow Meters Co. 8
Research Corp. 54
Revere Copper & Brass (Inc.) 26
Ric-Wil Co. 79
Rivett Lathe & Grinder (Inc.) 7
Robbins & Myers, Motor Div. 75
*Robertson, John, Co. 14
Rockford Clutch Div. of Borg-Warner Corp. 109
*Roots-Connersville Blower Corp. 37

*SKF Industries (Inc.) 90
*Sarco Co. 112
*Schutte & Koerting Co. 77
Smith, Winfield H., Corp. 47
Smooth-On Mfg. Co. 106
Sponge Rubber Products Co. 9
Standard Pressed Steel Co. 66, 109
Stuart, D. A., Oil Co. 66

*Taylor Forge & Pipe Works 101
*Taylor Instrument Cos. 84
*Terry Steam Turbine Co. 117
Thomas Flexible Coupling Co. 46
*Timken Roller Bearing Co. 4th Cover
*Tube Turns (Inc.) 52, 53

U. S. Electrical Motors (Inc.) 107

*Voss, J. H. H., Co. 48

Walworth Co. 88
Waterman Engineering Co. 104
*Westinghouse Electric Corp. 68, 110, 111
White, S. S., Industrial Div., S. S. White Dental Mfg. Co. 64
Wiley, John & Sons 106
Wisconsin Motor Corp. 54
Wolverine Tube Div., Calumet & Hecla Consolidated Copper Co. 85
Wood's, T. B., Sons Co. 102

*Yarnall-Waring Co. 35

ENGINEERING SERVICE . . . Page 118

Black & Veatch
Brown Engineering Co.
Buchsbaum, M., Design Consultants (Inc.)
Carlson Co.
Ehrco Die Casting Service
Hathaway, C. M.
Kendall, George H.
Lancaster, Allwine & Rommel
Myers & Addington
National Weld Testing Bureau
Oujevolk, George B.
Philadelphia Testing Labs.
Polachek, Z. H.
Sanderson & Porter
Sargent & Lundy
Stanley Engineering Co.
Tour, Sam & Co.

Advertisers in Previous 1950 issues but not in this issue

*Air Preheater Corp.
*Aldrich Pump Co.
*Allis-Chalmers Mfg. Co.
Allis, Louis Co.
American Lead Pencil Co.
*American Manganese Bronze Co.
*American Pulverizer Co.
American Steel Foundries, Elmes Engineering Div.
*Armstrong Machine Works
Aurora Pump Co.

*Bailey Meter Co.
Biddle, James G., Co.
Brush Development Co.
*Buffalo Forge Co.
Bundy Tubing Co.

Cassell, John R. Co.
*Chicago Metal Hose Corp.
Clarage Fan Co.
Cleveland Worm & Gear Co.
*Cochrane Corp.
Cone-Drive Gears Div., Michigan Tool Co.
Cumberland Steel Co.
Cuno Engineering Corp.

DuMont, Allen B., Labs.

Eagle Pencil Co.

Faber, Eberhard, Pencil Co.
*Foster Wheeler Corp.

*Gibson, Wm. D., Co., Div. Assoc. Spring Corp.
*Gifford-Wood Co.

Haering, D. W. & Co.
Howell Electric Motors Co.

*James, D. O., Gear Mfg. Co.
Johnson, Carlyle, Machine Co.

Kay Electric Co.
Klipfel Valves (Inc.) Div. Hamilton-Thomas Corp.
*Koppers Co., Fast's Coupling Dept.

*Liquidometer Corp.

MB Mfg. Co.
*Marlin-Rockwell Corp.
Mercoid Corp.

New Hampshire Ball Bearings
Nice Ball Bearing Co.
Northern Blower Co.

*Oilgear Co.
O'Neil-Irwin Mfg. Co.

Pacific Pumps (Inc.)
*Pangborn Corp.
Panoramic Radio Products (Inc.)
Petro-Chem Development Co.
Physicists Research Co.
Powers Regulator Co.
*Pratt-Daniel Corp.

*R-S Products Corp.
Rhoads, J. E. & Sons

*Standard Stoker Co.

United Screw & Bolt Corp.

Vickers (Inc.)
*Vogt, Henry, Machine Co.

*Wickes Boiler Co. Div. of Wickes Corp.
*Wing, L. J., Mfg. Co.

*Zurn, J. A., Mfg. Co.

Now available for oil hardening in entire range of thicknesses...

Brown & Sharpe Ground Flat Stock

To help you get even greater benefits from the money-saving, time-saving advantages of using stock accurately pre-ground to size, Brown & Sharpe now offers a choice of oil or water hardening steel in 16 different thicknesses from 1/64" to 1".

In eight thicknesses up to and including 3/16", a single type of ground flat stock now serves for hardening in either oil or water . . . a distinct Brown & Sharpe feature that eliminates the expense of keeping two types of stock on hand.

With this complete range of stock — 145 sizes, including 24 new sizes — you can meet a wide variety of requirements. Stock for oil hardening is preferred where intricate sections and parts with sharp corners or abrupt changes in form are involved . . . for water hardening, where slightly higher hardness is needed.

Continuous, repeat markings of type on each piece of Brown & Sharpe Ground Flat Stock make identification easy. Protective envelopes in different colors simplify handling problems.

Write for new descriptive folder.
Brown & Sharpe Mfg. Co.,
Providence 1, R. I., U.S.A.

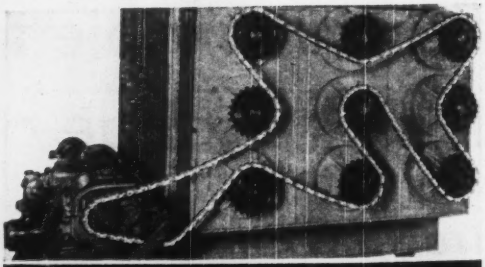
For templates, cutting tools, gages, machine parts and many similar pieces, there's a type of Brown & Sharpe Stock exactly suited to your specific requirements.

We urge buying through the Distributor

BROWN & SHARPE

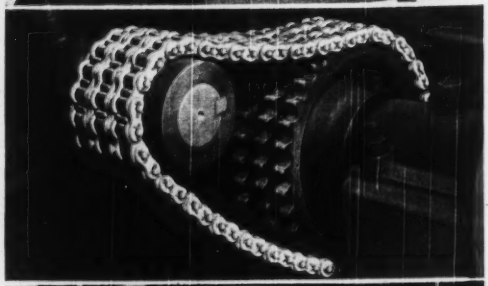
FLEXIBLE!

Link-Belt Precision Steel Roller Chain is flexible; a series of linked rollers that form a flowing highway of power.



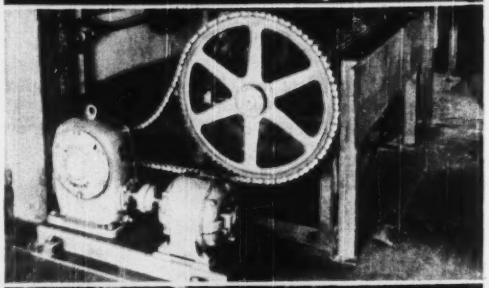
POWERFUL!

Link-Belt Precision Steel Roller Chain can be applied to small fractional horsepower machines or to units involving more than a thousand horsepower.



SHORT CENTERS!

Link-Belt Precision Steel Roller Chain can be used on short centers at high ratios. Adapted to withstand heavy starting loads and severe shock.



LONG CENTERS!

Link-Belt Precision Steel Roller Chain is adapted to coordinate motion of widely separated shafts, affording positive operations.

RELIABLE!

Made by Link-Belt—your guarantee of superior construction and proper design. Ask for Data Book No. 1957-A.

LINK-BELT COMPANY Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices, Factory Branch Stores and Distributors in Principal Cities. 11,475-B

LINK-BELT

ROLLER CHAINS & SPROCKETS

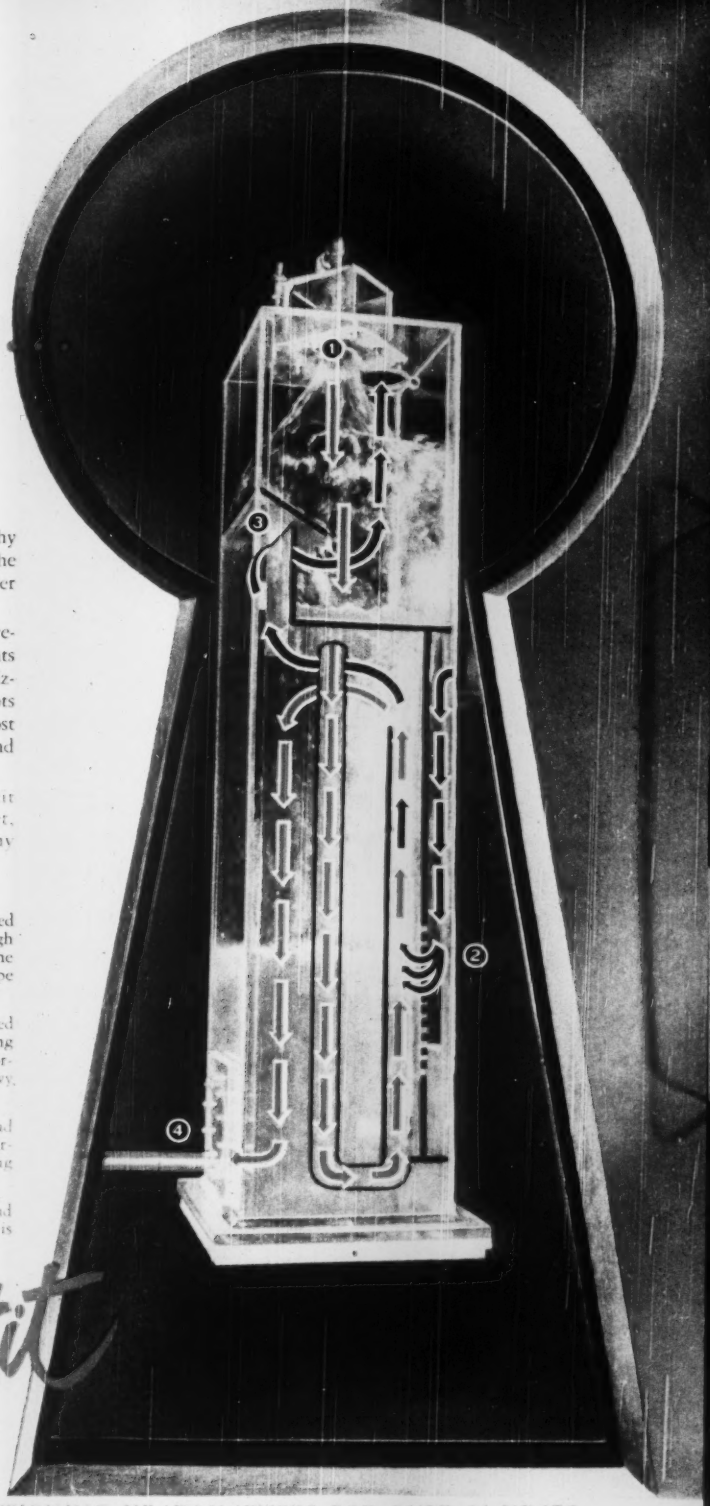
It will *pay* you to look into *this*.

The Permutit® Deaerator stops corrosion by removing all oxygen and CO_2

This transparent model makes it easy to see why the Permutit Deaerating Heater offers you the easiest, most thorough means of deaerating water for boiler-feed make-up.

Advantages of this equipment are many: It recovers waste heat economically and prevents corrosion of feed lines, stage heaters, economizers, and boilers. Operating noiselessly, it adapts itself readily to different steam pressures. Most important, the Deaerator is simple in design, and requires a minimum of maintenance expense.

Write for full information to The Permutit Company, Dept. ME-4, 330 West 42nd Street, New York 18, N. Y., or to Permutit Company of Canada, Ltd., Montreal.



1 FIRST STAGE. Cold water, entering here, is heated almost to steam temperature by spraying it through steam. This removes 95% of the oxygen. The water then travels downward through the pipe toward the second stage.

2 SECOND STAGE. Here the partially deaerated water is intimately mixed with steam entering through the scrubber. Violent boiling and vigorous scrubbing is assured for both light and heavy loads, and deaeration is completed.

3 The steam from the scrubber travels upward and enters the first stage of the heater, where it partially deaerates incoming water. The remaining steam is then vented to the atmosphere.

4 Here the completely deaerated water settles and may be drawn off. Ample water storage space is provided below the water control level.

Permutit

WATER CONDITIONING HEADQUARTERS FOR OVER 36 YEARS

15/16" cut removes 59.4 cu. in. of metal per minute with no sign of chatter!

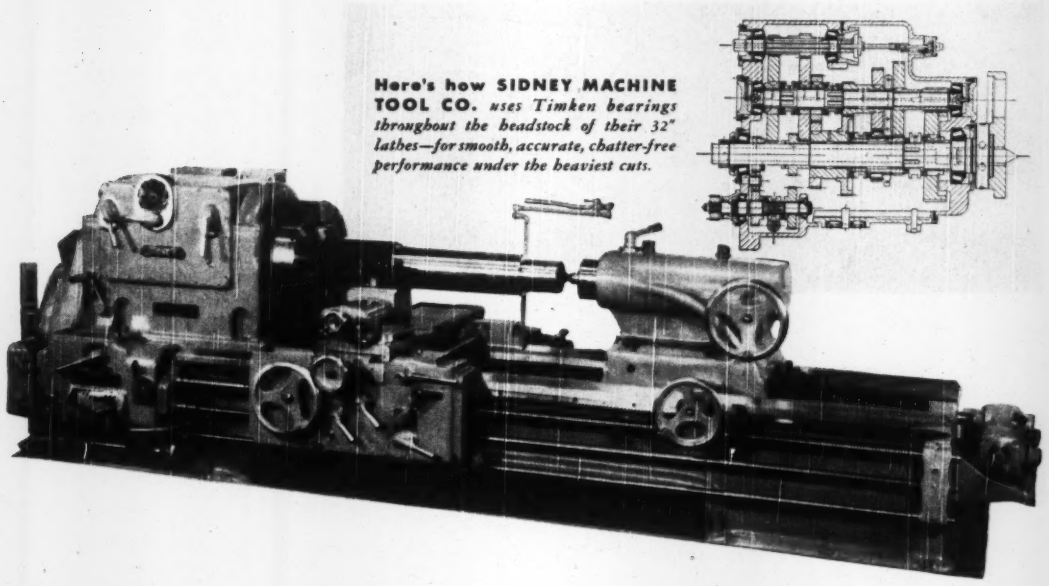
HERE'S a terrific test staged by the Sidney Machine Tool Company to demonstrate the capacity of their 32" lathes. Using a carbide tool without lubrication, this heavy cut was continued for 20 minutes without interruption. Yet no sign of chatter appeared on the work!

Mounted on Timken® bearings, Sidney lathe spindles stay rigid and free from vibration under the heaviest cuts. Due to the line contact between the rolls and races, Timken bearings give the spindle maximum support, minimum deflection. Tapered construction enables Timken bearings to carry both radial and thrust loads in any combination and permits accurate preloading.

Timken bearings are made of the best steel ever developed for tapered roller bearings — Timken fine alloy steel. True rolling motion and the finishing of the rolls and races to incredible smoothness practically eliminate friction. Fine bearing performance and accurate operation are assured throughout the life of the machine.

Backed by 50 years of bearing research and development, Timken tapered roller bearings are first choice throughout all industry. Make sure you have Timken bearings in every machine you make or buy. Look for the trade-mark "Timken" on the bearings. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best



Here's how SIDNEY MACHINE TOOL CO. *uses Timken bearings throughout the headstock of their 32" lathes—for smooth, accurate, chatter-free performance under the heaviest cuts.*

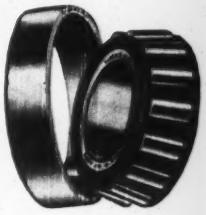
NEW TIMKEN BEARING CUTS RUN-OUT IN HALF!

Until now, the Timken "Zero" bearing has been the last word in bearing accuracy. Now Timken offers industry the "Double-Zero" bearing—*twice as accurate* as the "Zero"! Maximum run-out of the new "Double-Zero" bearing is only 75 millionths of an inch—*half* the 150 millionths run-out of the "Zero" bearing.

What an opportunity for manufacturers of machines where extreme accuracy is essential! Available in standard single row types, up to 10" O.D. Write for further information.

TIMKEN

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◐ AND THRUST ◐ LOADS OR ANY COMBINATION